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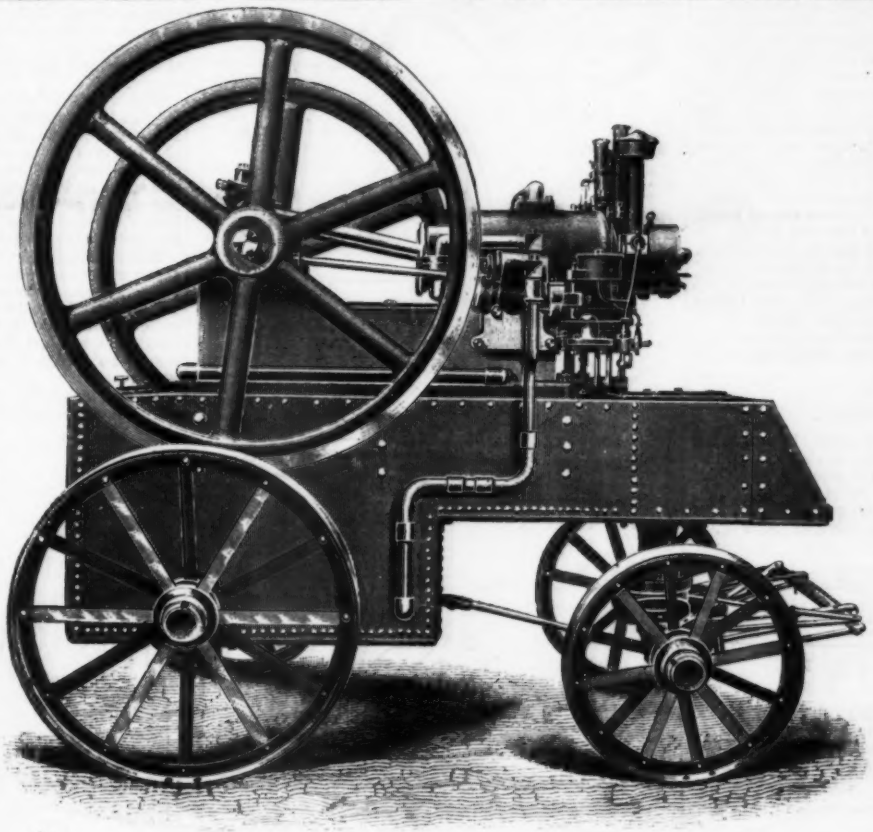
IMPROVED 8 H. P. PORTABLE OIL ENGINE.

MESSRS. Weyman & Hitchcock, Ltd., Guildford, this year at the Smithfield Agricultural Exhibition show an 8 h. p. portable oil engine of novel design, which we illustrate. It has two cylinders placed side by side with cranks together, so that—working on the four-cycle principle—an impulse is obtained at each revolution of the crank shaft. One side shaft placed between the cylinders, and driven by skew gear, works the valve levers, and a strong box pattern casting forms the engine bed and supports the crank shaft bearings. Two vaporizers are placed one at the end of each cylinder, each with an independent oil pump for the supply of oil. Three vaporizers can either be worked separately or both together.

On one side of the engine and driven by an eccentric from the crank shaft are two small pumps, one for circulating the water round the cylinder from the tank beneath and the other for blowing a small flame which heats the ignition tubes. This flame is obtained by an open wick supplied by oil from a neighboring vessel. The flame is contained in a small chamber, and is covered so as not to be affected by the weather. The asbestos-lined chimneys are also supplied with covers.

The engine proper is mounted on a large tank capable of containing about 400 gallons of water. The front end of this tank contains the oil vessel, which holds sufficient oil for half a day's run, and just underneath, at the fore end, but not so as to interfere with the turning of the fore carriage, are placed two exhaust boxes with an exhaust pipe for each cylinder.

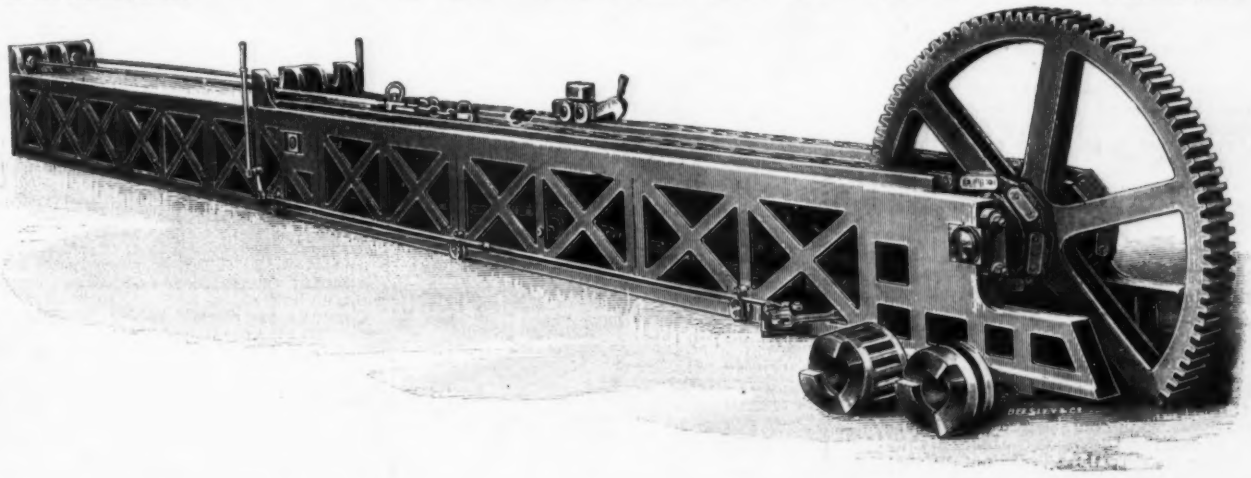


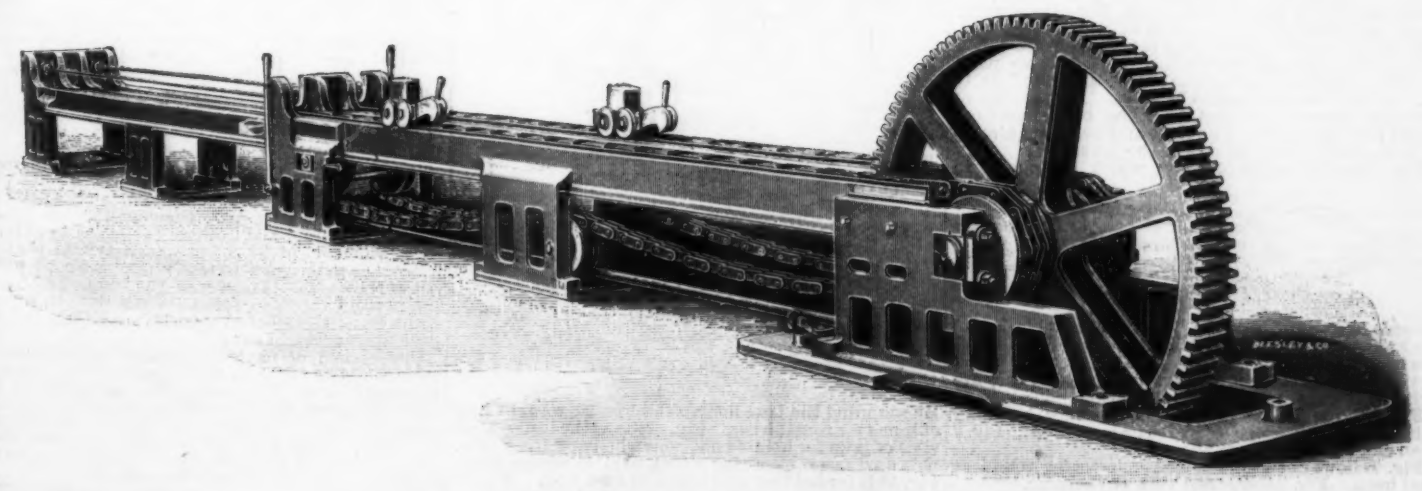
IMPROVED 8 H. P. PORTABLE OIL ENGINE.

To start the engine, an operation which takes from ten to fifteen minutes, two small blow lamps are placed one underneath each vaporizer, and when the vaporizers are sufficiently hot the engine may be started by turning the fly-wheel. The crank shaft stands about the same height from the ground as the ordinary portable steam engine. The weight of the engine complete and empty is 3 tons 12 cwt., being about one ton less than a steam engine of equal power. The over-all dimensions of the engine are about the same as the portable steam engine, but it is rather shorter in length. When packed for shipment, however, the over-all dimensions, with wheels off and fly-wheels packed separately, are considerably less than that of its steam rival. The approximate indicated horse power is twenty-five, and the brake horse power about sixteen. The consumption of oil is about a half pint per indicated horse power per hour, and in working a 4 ft. 6 in. thrashing machine and a 42 in. saw the consumption would be about one gallon per hour.—*Industries.*

IMPROVED DRAW BENCHES.

WE show two draw benches for the manufacture of cold-drawn seamless tubes. The lower bench, in which the stands are all bolted to retaining plates, being for heavy work, is especially strong in all its parts, and all the joints throughout, including the retaining plates and stands, be-





IMPROVED DRAW BENCHES.

ing planed, makes the whole, when bolted together and bolted down to its foundation plates, very rigid and firm, so that the work can be done not only better, but faster than on an inferior bench. The driving wheel being in the center of the bench instead of on one side allows the workmen to pass to the extreme end of the bench on both sides when drawing tubes, thus utilizing the whole length of the bench, and being able to draw on the one side a longer tube than if the wheels were on the outside of the bench. It may also be noted that the driving wheel being in the center of the bench, the power is more evenly transmitted, and with less strain on the bench and the bearings than when the wheel is on the outside.

The bench has a treble link chain, and both the links and the rivets of the chain are of steel, the links of the chain being drilled and also milled on the ends by tools specially constructed for this purpose. The bodies of the wagons on the bench are also of steel, and are carefully balanced so as to give a minimum of labor to the workmen in catching and releasing the same from the chain. The connecting bars and levers to the throw-out gear are under the bench, and thus clear from the feet of the workmen, and, being carried to the die plate on each side, enables the workmen to throw out the underground gear, and so stop the bench when necessary. The stems, mandrels, and dies, as will be seen, are carried by the front end of the bench. The upper bench, with the lattice supports, is intended for lighter work than the preceding bench, and although not planed on the joints, is firmly bolted together, and the chain, links, and rivets are of steel, and drilled and machined as in the heavier bench, although not so strong in section and not of treble links. The throwing-out levers are carried up to the die plate on each side of the bench, and the wheel is also in the center of the bench, as in the heavier one, and either balanced wagons or pliers are made for gripping the tubes, as preferred. These tube-drawing benches are made by Mr. S. Platt, of Wednesbury, England.—*The Engineer.*

HOW TO MAKE TONGS.

WITHOUT tongs the smith would make but limited progress. With good tongs a better day's work can be performed, with much less strain on the smith, than with those that are imperfect and worn out.

To make a plain pair of tongs for ordinary purposes, take ¾ in. square iron, and flatten down as A, Fig. 1;

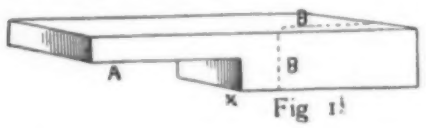


Fig 1.

X at the back edge of the anvil. Make A ⅜ in. thick. Next turn to the left and push over to front of the anvil, and draw down as per dotted line, B B, which forms the eye and gives the result shown by Fig. 2: C,

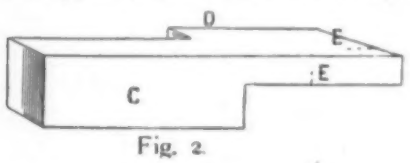


Fig. 2.

the jaw; D, part for eye. Turn to the left again, and still at the front of the anvil, and draw down or form "butt of shank," as per dotted line, E E, and get Fig. 3. F, the jaw, fullered in at center and within half an inch of the eye, G.

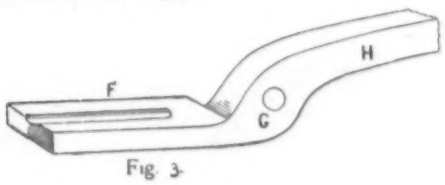


Fig. 3.

Have the jaws ¾ in. wide, ⅜ in. thick; the eye ¾ in. wide, ⅜ in. thick; and H, "butt of shank," also ¾ in. wide and ⅜ in. thick. Weld on 7-16 in. round iron, tapered to 5-16 in. at outer end. Punch the holes in the eyes for 5-16 in. rivet; place the tongs together and insert the rivet. Heat the hole, and rivet up while hot; and at the same time fit the jaws to pinch at ⅛ in. Make the jaws ¾ in. wide, 2 in. long. Make the shanks, tangs, or handles from 15 in. to 18 in. long.

Tongs of this description and made close are called close tongs. Each fire should have at least two pairs of such. The next pair in size ought to "bite" at ¼ in., and then increase in size by ¼ in. As the size of the tongs increases, so must the caliber of the iron from which they are made. The rivet and tangs require to be larger and stouter as well as the jaws.

Fig. 4 presents a pair of tongs which are placed in

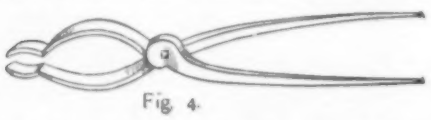


Fig. 4.

a staple in front of or at the side of the anvil block, and are known as "pick-ups." They are for the helper's use in picking up pins, punches, or tools, and to assist the smith when carrying heavy, hot forgings; they are light, so as to be handy of manipulation.

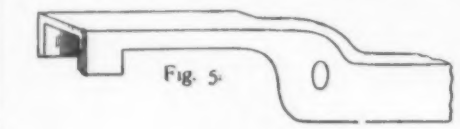
Fig. 5 shows top jaw of a pair of tongs for handling thin plates, such as spring plates or band irons. Fig. 6 is an end and top view of the same.

Fig. 7 shows one jaw of a pair of tongs for round or oval irons. Fig. 8 shows end view of the same.

Fig. 9 is a section of the ordinary bolt tongs. Fig. 10, end view of the same.

Fig. 11 presents the jaws of a pair of band tongs. Fig. 12 shows jaws of a pair of tongs for handling small, thin bands. Fig. 14 is end and top view of a pair of tongs for handling rings. Fig. 15 shows a pair for handling long, thin plates, such as spring plates.

Fig. 16 presents the top and end view of the jaws of a pair of tongs for square iron or heavy plates. Fig. 17 shows the top and end view of tongs for oval irons.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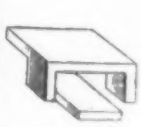


Fig. 6.

Fig. 7.

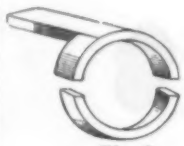
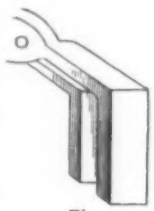


Fig. 8

Fig. 9.

Fig. 10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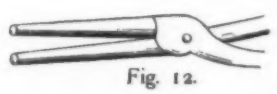
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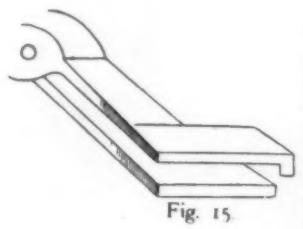
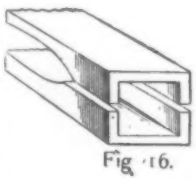


Fig. 15

Fig. 14.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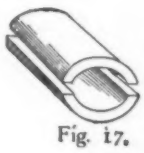
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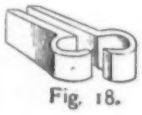
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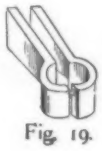
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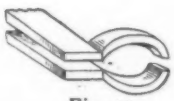
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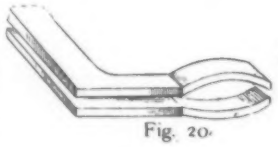
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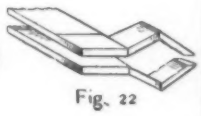
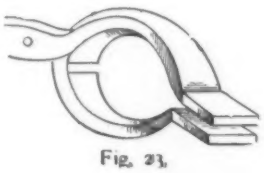


Fig. 22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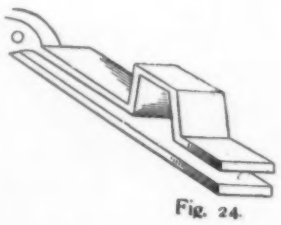


Fig. 24.

Fig. 25

By rounding the jaws more, as in Fig. 25, we get a pair of tongs for round irons. Fig. 18 shows the top and end view of jaws for holding flat irons when upsetting. Fig. 19 is used when upsetting round, oval, or square irons. Fig. 20 is for holding long pieces of oval iron. Fig. 21 is the same, prepared for round irons in long pieces.

Fig. 22 shows method of making tongs for holding long pieces of square iron. Fig. 23 presents what is called spring-fitting tongs. Fig. 24 presents the jaws of a pair of axle clip tongs.

This comprises the general list of tongs; others, for special forgings, will be presented in connection with the work to be performed.—*The Hub.*

PROPOSED ELEVATED SIDEWALKS FOR BOSTON.

THE latest suggestion made in regard to relieving our streets and insuring the safety of pedestrians is that of Mr. Hannah, of the real estate firm of S. D. Hannah & Co., of this city, and illustrated herewith. As will be seen, it consists simply in elevating the sidewalks above the streets to the line of the second story, and throwing the whole area of the street—that is, the sidewalks on either side—into the roadway.

As to details, the structure can be of iron or steel, comparatively light in weight, and being secured on one side to the buildings, would not require the amount of trussing which an independent street structure, like that needed for elevated railway tracks, would demand.

The walks on either side of the street, and the crossings at intersections, would be composed of iron, glass, and concrete, a sufficient amount of the iron being in the shape of pipes, which could be connected to exhaust steam pipes, and be thus used in winter time to thaw the snow as it fell, or ice, if it should form, the resulting water, as well as the rain which fell at all seasons, being carried off in gutters and spouts down through the hollow iron supporting columns.

The structure forming this system of sidewalks would serve other and useful purposes, some of which may be enumerated. While some of the supporting hollow pillars may be used as rain and snow water conductors, others could be utilized as continuations of surface hydrants, so that the coupling of hose, in case of fire, could be effected on the level of the elevated sidewalk.

It can easily be seen how conveniently the trolley wires of the electric road could be supported in the

PROPOSED ELEVATED SIDEWALKS.

center of the street, and the present supporting posts dispensed with. The feed wires could be carried on one side of the track, or both sides; under this sidewalk, on both sides.

Conduits for electric cables for light, power, telegraph, and telephone purposes could be cheaply established, and a considerable revenue be derived from them by the city. Not only these, but such a construction might be used for the support of gas mains (suitably protected), and for some system of rapid transfer of parcels and mail matter, such as a pneumatic system or one identical with or similar to the portelectric system now being put in in Chicago.

In fact, such a structure would, it is claimed, present all the advantages of a street railway at a fraction of its cost, without many of its disadvantages. Besides enabling an enlarged roadway on the ground level, it would do away with all the dangers and interruptions incident to pedestrianism. It would also enable a very important reform in the classification of traffic on different lines, by devoting certain streets to certain kinds of traffic, so that one kind would interfere as little as practicable with another.—*Boston Herald.*

TRANSFER OF BOATS ON RAILWAYS.

AT the time that our railway system comprised only isolated trunks without any communication between them, the Laffitte and Caillard Society devised for the transshipment of its diligences a system that permitted its passengers to reach Paris without getting out of the coach. As soon as the "patache" reached the nearest railway station, its wheels were removed and a crane then loaded vehicle, passengers and baggage upon a freight car.

Our system of navigable watercourses is scarcely more complete at the present time than was that of the railways in 1850. They often flow alongside of each other for great distances without its being possible to pass from one to the other on account of the difference of levels. Thus, the Ourcq Canal and the Marne, sensibly parallel from Meaux to Paris, have no communication except through the capital.

The inconveniences to river navigation that resulted from this may be readily understood. In order to pass

a canal boat on the Marne to Meaux, or *vice versa*, that is to say, to cause it to traverse a distance of less than half a mile, it was necessary to make it pass through Paris, in other words, to submit it to a voyage of 60 miles.

In order to remedy the loss of time and money consequent upon this state of things, Mr. Jules Fournier, a transportation contractor of Meaux, has conceived an idea analogous to that of Laffitte and Caillard. He no longer carries the diligences, but the boats, all loaded, from one route to the other. As the difference of level between the Ourcq Canal and the Marne is 40 ft., it would have required, in following the habitual methods, in order to form a communication, to establish four or five locks, the cost of which would have been out of proportion to the object to be attained.

Mr. Fournier has confined himself to the construction of two small ports on the border of the watercourses at the place where they are nearest each other, that is, at Beauval, above Meaux. The boats are carried upon submerged cars running on rails from one port to the other.

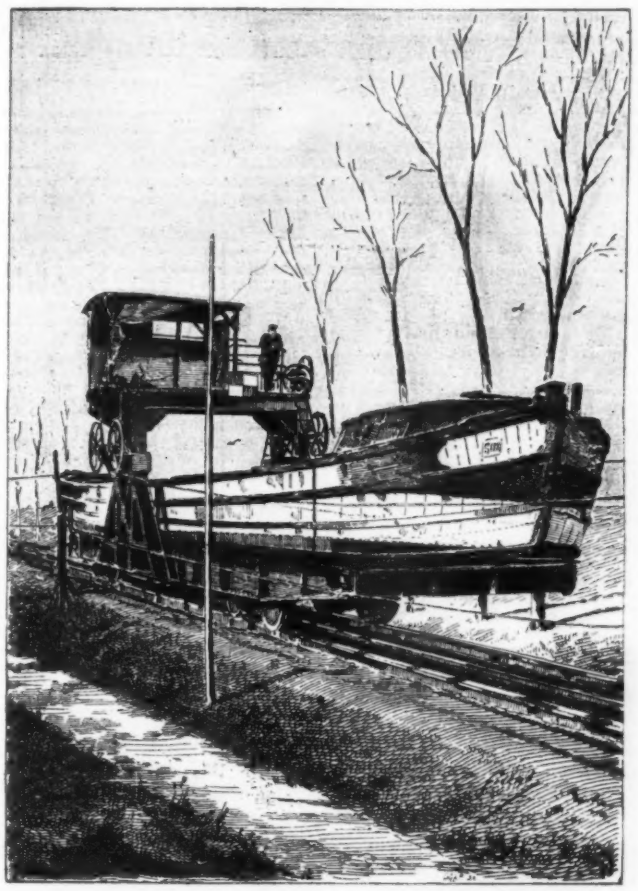
The work, skillfully executed by Civil Engineer Mallet, has not cost more than $20,000, inclusive of *materiel* and earthwork, and, since its completion, about a thousand boats, weighing 75,000 tons on an average, have been transshipped without the least accident.—*Le Monde Illustré.*

THE MYSTERY OF STEAM.

CAN steam flow from a region of higher pressure into a region of lower without undergoing liquefaction? There is no direct intimation given to the contrary in any text book of thermo-dynamics. Rankine, indeed, states the conditions under which such a flow may take place, with the result that the steam will be slightly superheated; and he was no doubt right, but only within limits, the significance of which is usually overlooked. The practical importance of the question which we have asked will be understood when it is borne in mind that in steam engines the steam always flows from the region of higher pressure, the boiler, to the region of lower pressure, the cylinder. If it can be shown that under such conditions liquefaction must take place, it follows that nothing that can be done in the way of using a cylinder of non-conducting materials can totally stop what is known as initial condensation; and that being the case, we shall have to seek the attainment of maximum economy not in jacketing, but in converting steam by superheating into the condition of a gas, which certainly does not undergo liquefaction in flowing from a region of higher to one of lower pressure.

Before any answer can be given to our question, it is necessary to consider what the nature of steam is, and in what way it differs from the so-called permanent gases. The main difference lies in the relation which the sensible and latent heats bear to each other in the gases. The latent heat, as a rule, that is to say the heat converted into work in converting the gas from a liquid to a fluid, is probably very small as compared with the sensible heat. In other words, all the gases are enormously superheated at ordinary temperatures. In ordinary non-superheated steam the proportion is much larger. Taking water at 32° Fah., and converting it into steam at 212° Fah., Isherwood thus divides the work: Representing the total as 100, we have expended in raising the temperature of the water from 32° to 212° 15·776 per cent.; in increasing the volume of the water between 32° and 212°, 0·0002 per cent.; destroying the cohesion of the water, that is, converting it into steam, 77·940 per cent.; and in increasing the volume of water from that which it had at 212° to that which it has in steam, 6·282 per cent. The whole of the heat is thus accounted for, and in a certain restricted sense it may be said that steam possesses no intrinsic energy. All that the water has received in the form of heat has been expended in producing *and maintaining* a change of state. That is to say, it can perform no external work of any kind without undergoing a change of condition. It contains just heat enough and no more to maintain it as steam. The total amount of work done upon it is accounted for by its change of state from water to steam, and the moment it is compelled to do work it gives up some of the heat necessary to its permanence of state, and undergoes liquefaction. In other words, ordinary boiler steam is in the condition known to chemists as the critical state; and the least augmentation of heat will, on the one hand, superheat it, while, on the other, the least withdrawal of heat will cause partial liquefaction, and the heat may be withdrawn in either of two ways, namely, by the performance of work or by the subtraction of heat.

Let us, to simplify matters, suppose that we have a triple expansion engine, the cylinders, pistons, etc., of which, instead of being made of iron, shall be composed of a material which is absolutely neutral, which will neither absorb nor emit heat, which can neither conduct it nor radiate it. Let the steam be quite clean and free from suspended water. Will or will not liquefaction take place in the first cylinder, with which we shall alone concern ourselves? Beyond all question, liquefaction will take place due to the performance of work, and amounting in round numbers to about 2·5 lb. per horse-power per hour, and this power will be very much in excess of the indicated power developed in that cylinder, because of the work done in overcoming the high back pressure. But is it reasonable to expect that liquefaction takes place from any other cause? We think it is, and practice and experiment both go to show that it does take place, although it is not easy to give the precise reason why. Mr. Donkin has, with that engergy and perseverance for which he is remarkable, gone on adding to and modifying the glass experimental apparatus to which we have often referred. By putting a second glass cylinder outside the first, with an air space between, changes have been produced in the phenomena. It will be remembered that the apparatus is so coupled to a beam engine that the steam enters it and exhausts from it just as though it were a real steam cylinder. The presence of the hot air space appears to prevent the formation of drops on the glass inside, but the water coats the surface at each stroke, and runs down in an even layer. The surface is unformly wetted, in fact. It is easy enough to see through this what goes on. The supply of steam enters through a pipe in the center of the upper cover of the cylinder. Now, the moment the valve opens, steam rushes in, not transparent but in a cloud, which clears up instantaneously, and then mist forms again, and remains until the exhaust port opens, when rapid re-evaporation takes place, and the inside of the cylinder becomes quite clear. The opening of the steam valve is again followed by the entry of, as it were, a puff of smoke, which clears up as before described, and so on. This is, we think, a most suggestive experiment. We have here an entry of wet steam followed by dry steam at each stroke, and it must be remembered that all the steam pipes, etc., are carefully clothed, Thus, then, it appears that steam flowing from a region of high pressure, the steam pipe, to one of low pressure, the cylinder, is instantly liquefied. Why? No contact has taken place between the steam and the metal or glass of the cylinder. The cylinder no doubt contains steam of a temperature and pressure proper to the condenser, and in mingling with this some liquefaction must be caused in the entering steam; but it is easy to see that the quantity of low pressure vapor present weighs far too little to produce an appreciable effect. We must, then, seek for some other cause, and if possible find one which will not only explain the results obtained by Mr. Donkin, but which will cover a very much wider range. And here it may be said, without hesitation, that if we could do this, we should at once be in a position to formulate a far more satisfactory theory of the steam engine than any which has yet been promulgated.



TRANSFER OF BOATS ON FRENCH CANALS.

Let us consider first what are the phenomena of liquefaction. If we refer to the text books, we shall gather from them that steam contains heat in two forms. One is known as "sensible" and the other as "latent," and we are told that the sum of latent and sensible heats is very nearly constant, undergoing a small augmentation as the pressure rises. Thus, for example, the total heat from 32 deg. Fah. with an absolute pressure of 70 lb. is 1174·28 deg., while at a pressure of 140 lb. the total heat is 1189·90 deg. But in point of fact the term "latent heat" is misleading. There is no heat in the steam but that which can be measured by the thermometer. Thus, with 70 lb. steam the actual heat present is 302·7 deg., while the so-called latent heat is 900·8 deg. The latter quantity has disappeared. It has been wholly converted into work. It represents the 77·9 per cent. mentioned above, and has been expended in destroying the enormous molecular cohesion of the water and imparting to the molecules an energy quite similar in kind to that possessed by the permanent gases. But the mere driving apart of the molecules is not sufficient. They continually tend to run together again under the influence of external pressure, and this is only prevented by the presence of true heat. If, then, there is any loss of heat, there will be liquefaction, and the molecules in coming together give back the whole of the work that was expended in separating them, and this reappears as heat, and this heat, unless withdrawn in its turn, prevents further liquefaction from taking place.

We have now to consider whether it is or is not possible for steam to liquefy without losing sensible heat. It is extremely difficult to give an answer to this question, because it appears to constitute a problem insoluble by direct experiment, except to a very limited extent. The liquefaction which takes place in a steam cylinder is far too complex a process to help us much. There is, however, some reason to think that under certain conditions steam will expand and do work, and yet not lose sensible heat. It is of course impossible to deal with this supposition on any positive basis. But one experiment may be named as bearing on it. Let us suppose that the classical experiment of Joule with compressed air is repeated with steam. It is about as certain as anything can be that liquefaction would take place in the first bottle, and superheating in the second: and yet there would be no loss of heat as a whole, and no external work would be done. Theoretically, on suffering the contents of the bottles to mix again, the water of liquefaction ought to re-evaporate. Let us now apply this experiment to a steam engine. We have a steam pipe which is full of steam—that is the charged Joule bottle. We have the cylinder, into which the steam rushes, the moment the valve opens the steam port—that is the second Joule bottle. Under these circumstances it seems to be fair to conclude that liquefaction will take place in the steam pipe, and the water so produced will instantly afterward be blown straight into the cylinder; but we know that under these conditions the water will be "knocked out of the steam," and will never be re-evaporated until the pressure falls during expansion. Again, when the steam is passing during exhaust into the intermediate receiver, it is by no means impossible that liquefaction may take place in the high pressure cylinder in precisely the same way. All the time, although liquefaction is taking place, there is no direct withdrawal of heat, but there is, so to speak, a change in its location from one place inside the engine to another.

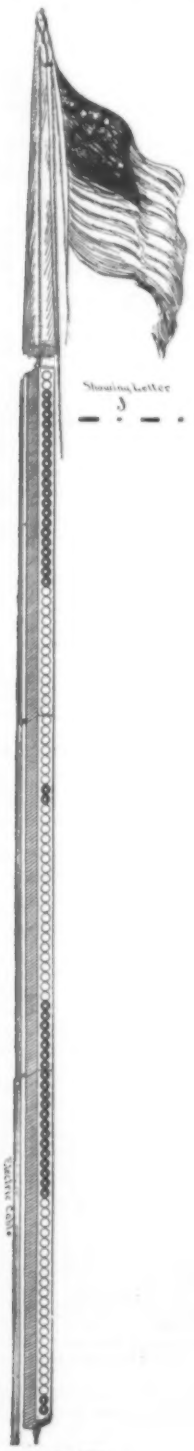
There is another aspect of the question which deserves careful consideration: Can steam lose latent heat—we use the words simply for convenience—without losing sensible heat, and in that case what would happen? In other words, Can steam undergo liquefaction without cooling? We do not think too much weight should be attached to the conversion of heat into work on the piston of a steam engine, because no one knows whether the molecular energy of the steam first reappears as heat, and is then converted into mechanical work, or whether the change takes place direct. We are as ignorant on this point as we are as to how a bearing heats. But the importance of the question may be gathered if we keep in mind that but one cause of liquefaction is ever considered by those who attempt to improve the steam engine. They assume, one and all, that the only cause of liquefaction is the abstraction of sensible heat. "Keep the cylinder and all connected with it hot, reduce the range of temperature in the cylinders by multiplying their number, and the best results will ensue." If, however, it can once be shown that the energy of the molecules —otherwise the latent heat—can disappear without ever reassuming the form of sensible heat, we have at once a different picture of the action in a steam engine, and we begin to perceive that it may not be enough to keep the cylinder hot, but that something else must be done.

It is, we think, desirable that before we conclude we should explain that we have been as careful as possible to avoid dogmatizing. Our object has simply been to suggest. It may, perhaps, be contended that we have said things which are quite inconsistent with the learned views of the authors of various treatises on thermo-dynamics. We do not think that this is really the case. But if it be, then let us consider next whether any writer has been able to give a satisfactory explanation, based on text book thermo-dynamics, of what really goes on in a steam engine. The answer must be in the negative. The extraordinary anomalies which in practice we continually encounter cannot be all explained on any existing theory. It is quite impossible, however, to make any progress to the true solution of the difficulties and perplexities we meet with daily, unless possible, if not probable, solutions

are suggested, examined, and appraised at their proper value. That steam is not a gas, and does not behave like a gas, is certain. The assumption that liquefaction can only be caused by the direct abstraction of heat, or the performance of work in impelling a piston, appears to be untenable. The shape of an engine, and the arrangements of its parts, appear to exert a most powerful influence on the consumption of steam. The amount of liquefaction appears to be absolutely independent of the range of temperature in a cylinder. There appears to be no certain relation between the expenditure of steam and the use or disuse of a jacket. It is time, we think, that physicists opened their eyes to these things, and devoted their attention to an investigation of the real properties and peculiarities of steam. The altogether too prevalent notion that Regnault, Fairbairn, and Rankine have left nothing to be learned should be dismissed forever. Mr. Donkin has already proved its futility. It will be time enough to close the whole inquiry when it has been definitely ascertained how the heat generated in a furnace becomes converted into indicated horse power, and not till then.—*The Engineer.*

AN IMPROVED ELECTRIC LIGHT SIGNALING APPARATUS.

THE present method of signaling at sea by codes, with flags, cones and lights, is often tedious, and in many cases there is a good deal of ambiguity about



SIGNAL STAFF.

the signals or a want of the necessary thorough understanding between the sender and receiver.

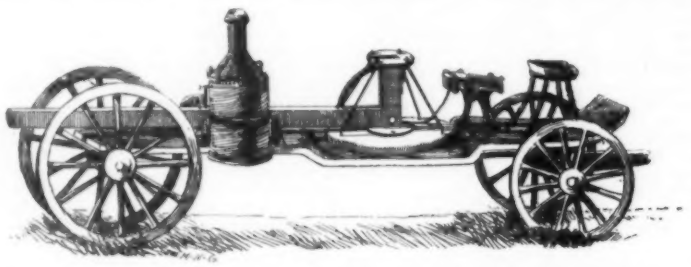
So also in signaling upon land, by means of semaphore and heliograph, etc., there is always a wide margin for mistakes, aside from the tediousness of the work and the necessary limitations of this method of communicating information. The accompanying illustrations represent an improved method of signaling, designed to meet all the requirements of such a service, both upon sea and land, and adapted for day or night use. The improvement is styled the "telephotos," and is the invention of Mr. C. V. Boughton, of Buffalo, N. Y. The Morse alphabet is employed in this signaling apparatus and, by means of novel and ingenious electrical connections, the signs indicating each letter of the code are simultaneously displayed by simply pressing once upon a single key, after the manner of operating a type writer, the dots and dashes then being marked by corresponding bars and beams of electric light, with distinctive intermediate spaces, upon the side of a suitable signal staff.

That the device should be entirely practical, and adapted for the widest range of service, it was necessary that the dimensions and weight of the apparatus should be kept within the closest limits, that it might be readily portable. The machine case, therefore, is of aluminum, irregular in form, and occupying an area of 2½ feet square by a depth of 6 inches. Of this area, 1 foot 6 inches is taken up by the keyboard, with 37 letters, numerals, etc., the remaining portion being taken up by the several thousands of electrical connections required. Outside this area the connecting wires are gathered and stopped together as an unstranded cable of 1¼ inches diameter, and led to the light frame. The latter is also of aluminum, made in three parts, with the two ends folding upon the center, in which position it measures 9 feet by 1 foot square, and when extended for use, 27 feet by 6 inches square. It contains 106 incandescent lights of 32 candle power (lamps of any power up to 110 candles can be used with a possible elongation of the frame to 28 or 29 feet). On reaching the light frame, the cable spreads out, each separate wire going to its proper lamp. Each lamp is numbered, and each binding post and cross bar within the machine bears the corresponding figures, so that any lamp failing to respond to the key touched, the cause is easily traced, and as easily remedied, even to a defective wire, which, if ever necessary, can be traced, withdrawn, and replaced by a new one in a few minutes. New lamps will burn for 600 consecutive hours, and when exhausted can be replaced as rapidly as those in everyday store use. The weight of the keyboard will not exceed 75 pounds and that of the light frame 120 pounds.

The lights at night will be visible at distances equal with other electric lights of like power, and experiments now made with lenses encourage the belief that eventually the telephotos will be readable from distances beyond the reach of flags in broad daylight. Two lights form a dot, and the minimum of a dash is 20 lights, or five feet. The blank space between dashes and dots occupies the same length of space, five feet. Two red lights mark periods. By a very simple arrangement the apparatus can be changed as desired for secret signaling, by means of a thumb screw and ratchet, whereby the letters and characters are transposed as desired. When two instruments are talking with each other, the one receiving would acknowledge the symbols as received, and in case of secret signaling the characters of each instrument would be shifted in the same way.

On shipboard the keyboard can be located where most convenient, as any length of wire can be used in connecting it with the light frame, and the latter may be occasionally, as required, hoisted to or permanently fitted at any desired point, and read vertically, or it can be laid along the hammock rail and read horizontally; the same applies to semaphore, signal stations, light houses, and light ships A simple mechanical arrangement will turn the light frame in any direction when permanently fitted to a mast.

For field work, a special wagon with appliances for raising and lowering the frame is designed, and the weight and requirements for handling will stand comparison with what field telegraphy calls for. The weight of the wagon filled with apparatus will not exceed 1,500 pounds. An attachment for the automatic printing of the messages sent and received by the apparatus, by which, it is said, 72 letters have been practically sent and read per minute, has been added. It will only print the letters in Roman characters when the light has been clearly displayed. The signal is designed to be plainly visible for about three miles by day or ten miles by night.



TRUCK AND TURNTABLE FOR BOUGHTON'S "TELEPHOTOS."

BOUGHTON'S "TELEPHOTOS," FOR DAY AND NIGHT SIGNALING.

ORANGE, TEXAS.

ORANGE is essentially a lumber town and one that possesses great natural advantages as a distributing point for the product of the forests of east Texas and western Louisiana. In outward appearances it is rather above the average of Southern towns, possessing a number of good business blocks and a general air of thriftiness. Situated on the Texas side of Sabine River, 35 miles from Sabine Pass, and within tide water, the average depth of the river's channel is well maintained the year round, only varying at times of extreme high water. Owing to the rise and fall of the tide, logs in the river booms float down stream in the morning and back again about three o'clock in the afternoon. This gives an advantage in the way of storing logs, for in case any should happen to get by the booms coming down, they can be recovered without trouble after the tide turns.

Sabine River has a depth at Orange, and for quite a distance below, of from 40 to 60 feet, and all that is lacking to make of it an excellent deep water harbor is the removal of the bar at Sabine Pass. This is being done as rapidly as the meager assistance received from the government will admit. It has been hard work getting the necessary appropriations from Congress, but the lumbermen of southeastern Texas have persisted in their efforts, and can point to satisfactory results.

In 1888 the pass showed a depth of six feet, which has been increased from year to year, until there is now an average depth of nearly fifteen feet. It is proposed to continue deepening the channel until the largest ocean vessels can come up the river, and when this is accomplished Orange is destined to become one of the leading gulf ports. With the present depth there are fairly large shipments of lumber, both coastwise and to South American ports, but only one concern makes much of a feature of foreign trade.

Rail facilities are afforded by the Southern Pacific. The distance by this road from Orange to Houston is 105 miles, and from Orange to New Orleans 246 miles. The town is built on the outward curve of a sharp crescent, and has something over 5,000 inhabitants. The land here is rather low, the banks of the river being only a few feet above water level in the business por-

tion of the city, and the Wingate, Orange, and Gilmer mills are built on made ground on a projecting bend of the river above town. The Bancroft and Lutcher & Moore mills, further down stream, are on fairly high ground, the banks rising somewhat below the city, but again dropping down to almost marshiness where the plant of the L. Miller Shingle Co. is situated.

There is no timber immediately surrounding Orange, and if there ever was any, all signs of it have disappeared. The mills obtain their supply up the river, beginning at Niblett's bluff, a distance of seven miles cross lots, but twice the number following the bends of the river. It is not often that any trouble is experienced in getting logs down, it only being necessary to dump them into the stream and allow them to float to the booms. For some distance above and below town the river, except at the landing, is filled with storage booms. These booms are all strongly constructed and present an unusually neat appearance. The groups of piles to which the booms are attached are all boxed up with plank, and the booms themselves are made of sawed gunnels or heavy timbers. On these booms one can walk the entire distance from the upper to the lower mills without trouble.—*N. W. Lumberman.*

THE DISAPPEARING LADY AND BOY.

UP to a certain point, certain experiments have the appearance of those performed by prestidigitators, but their *denouement*, which unmasks the trick employed and provokes laughter, ranks them among the pleasantries of mimics and clowns. We shall recall a few of these farces (for they can scarcely be called otherwise) that are very well conceived and that excite the laughter of the spectator so much the more in proportion as they have begun by astonishing him.

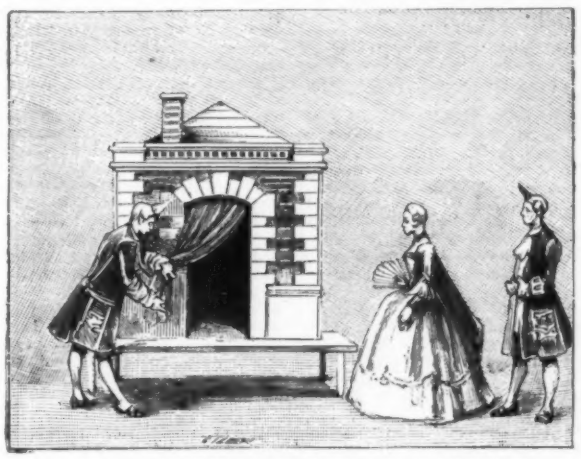


FIG. 1.—DISAPPEARANCE OF A LADY.

One of these very amusing exhibitions is that which consists in causing the disappearance of a lady in the middle of a circus ring. This is presented in the following way: In the center of the ring, and consequently in full sight, upon a plain table, well isolated, very thin and without a covering, and in which it would therefore be impossible for a person to hide himself, the clowns, before the eyes of the spectators, construct a house with light painted panels. Well satisfied with their work, it is their wish that the house shall be inhabited. Then two of them put on livery and transform themselves into domestics of good style. They make their exit and soon come back, respectfully following a lady whom they help to get upon the table and then to enter the house, which is afterward completely closed (Fig. 1). Their continue their role, bringing the lady a fan, flowers, and refreshments, enter, come out, become more and more active, and end by overturning the house, which, to the profound amazement of themselves and the spectators, is empty, the lady having entirely disappeared. The following is an explanation of the trick. The clowns dressed as domestics are two in number, and every time they enter the house they take and hide under their clothing a portion of the costume of the lady, who, naturally, is one of their comrades. This goes on until the third clown, dressed under his female garb as a domestic, like his companions, is stripped of his provisional clothing and makes his exit amid the goings and comings, with the busy air of those who are continually entering and departing. No one remarks that, instead of the two domestics first seen, there are three, and the less so in that one of them goes out of the ring before the fall of the house. His exit is entirely unobserved among the habitual promenades of the *personnel*, other clowns, horsemen, and grooms.

Another trick of the same nature, but of a more burlesque character, is the following, which is performed upon a stage, instead of in a circus: The clowns, generally two in number, amid their exercises intermixed with whimsical inventions, propose to each other to play the magician. One of them immediately takes a large cloak, wraps it around him, and puts on a pointed hat. Then he seats a little boy upon a chair, and begins by placing an egg, an apple, a goblet, or any other object upon his head, and then, with the tips of his fingers, so that no disappearance may be suspected, he puts on the child's head a hat that covers the object. He lifts the hat several times to show that the object is still there, and then suddenly lifts it for the last time, when, to the great astonishment of the spectators, the object is found to have disappeared. The companion of the make-believe magician is amazed, but all at once he bursts out laughing, seizes the arm of the operator, and shows that the hat was provided with an aperture behind, and that this, on lifting it for the last time, permitted of the passage of one hand and the removal of the object, while the rim of the hat was grasped by the other hand.

The mystified companion then proves to the operator, in boxing his ears, that he is not much of a magician, seizes the cloak and pointed hat, and promises to cause the disappearance of the child seated upon the chair. In fact, he takes a shawl, places himself gravely behind the chair and envelops the latter and the child with the magic covering, and takes the child concealed by the latter upon his back.

This farce, which begins as if it were a serious performance and which ends in a burst of laughter, has always a great success.—*La Nature.*

FIGS. 2 AND 3.—DISAPPEARANCE OF A BOY.

THE WORLD'S COLUMBIAN EXPOSITION OF 1893.*

By JAMES DREDGE, Member of the Royal British Commission.

1. *Introductory.*—On two previous occasions I have had the privilege of addressing an audience in this room on the subject of the World's Fair which is to be held in the city of Chicago next year. In December, 1890, the date of my first paper, but little was known of the project in this country, and it then was, in fact, full of uncertainty and of somewhat doubtful issue. The city of Chicago had, indeed, received from the United States government the privilege of holding the exhibition, and felt no hesitation in facing the material and financial difficulties connected with the undertaking, the extent of which was quite unknown. The site had not been definitely decided, and nearly the whole area finally allotted to the purpose was little better than wilderness.

The general plan of the exhibition was unsettled, and no detailed designs had been commenced. The administrative organization had to be formed, and there was as yet no work for an executive staff. In short, all was uncertain except the determination of the people of Chicago that the World's Fair of 1893 should be the greatest, the most magnificent, and the completest exhibition that had ever astonished the world. And not for a single moment, since it was first formed, has this determination faltered. How far it has been materialized can only be fully judged next year, but I hope this evening to enable you to arrive at some conclusion on the subject.

2. At the date of my second paper, read before you last December, a marvelous progress had been effected. Organization was complete; the general plan of the exhibition had been settled, and, with a few changes, has been strictly adhered to. The designs for the various great buildings had been prepared by the architects of many States; these designs had been approved, important contracts had been let, and much work had been done, although, with the exception of one building, but little was visible above the surface of the ground. Although the site of the exhibition had been contracted within the limits of Jackson Park, the extent and designs of the buildings had so far exceeded the original intention as already to give anxiety to those responsible for the finance of the undertaking. Foreign nations had, through their respective governments, signified their intention to participate, and had thus raised the exhibition to full international dignity; opposition and prejudice were rapidly dying out of America, and interest was beginning to be aroused in Europe.

Almost all the States of the Union had voted large sums for collective exhibits, and the system of classifying the contents of the exhibition had been settled in detail. Besides all this, much work peculiar to the Columbian Exposition was in full and active progress. The nominal reason for holding it was the celebration of the four hundredth anniversary of the discovery of America by Christopher Columbus. No temple raised in honor of the tutelary saint of the New World could be complete unless every available relic were collected there within a suitable shrine. Therefore to Central America, to the West India Islands, and to South America messengers were dispatched by the United States government, with instructions to secure as loans, and in many cases as purchases, objects directly associated with the memory of the great discoverer, and not only of Columbus, but also of the chief of those adventurers who succeeded him, seeking conquests in the New World. The shrine in and around which these relics are to be displayed will also have a direct association with Columbus. It will be the reproduction of the Convent of La Rabida, near Palos, where the Spanish celebrations took place in October last; it will stand upon a height overlooking Lake Michigan, and below it will be moored the reproductions of the three vessels that formed Columbus' fleet, and which took so conspicuous a part at the celebrations at Palos above referred to.

This may be regarded as the sentimental portion of the exposition, although its effect will be more important than that of simply arousing enthusiasm in the American people. Those countries which have contributed these relics are purchasing, but not manufacturing countries; to a very large extent they are our customers, but the American manufacturer and merchant see no reason why they should continue to be so, and it is not an unreasonable ambition on their part that, after the sentimental effect has evaporated, a good residue of profitable commerce taken from ourselves should remain. It is for our manufacturers and merchants to realize this danger that awaits them—a danger which can be averted if proper care be taken, but which will certainly fall upon us if we do not modify our present system of foreign trade, and continue to persist in the belief that England, by divine right, must always control the commerce of the world.

3. *Progress of Works.*—It is very difficult to convey an idea of the work that has been done in Jackson Park in the short space of twelve months, during which time many precious days were lost by stress of weather. Even the directors and the engineers of the exposition must be lost in astonishment at what they have accomplished, and it is well to emphasize this, because results, however great, are so easily forgotten in the rapid age in which we live. A few facts and figures may help to do justice to the work achieved, and to those who have accomplished it.

It was in April, 1890, that Chicago was selected as the city of the exhibition by Congress; three months were occupied in preliminary financial arrangements, and the first practical step taken was the appointment of Messrs. F. L. Olmsted & Co. as consulting landscape architects; this was in the August following. In September Messrs. Burnham & Root were appointed consulting architects, and Mr. A. Gottlieb as consulting engineer. The general plan of the exhibition was decided upon in November, and the designs of the chief buildings were intrusted to architects of prominence in various cities. These designs were not accepted before the close of the winter of 1891, and in March the necessary staff was organized for the preparation of the work. The duties of the architects who prepared the designs did not extend to details of construction other than those connected with the facades; all internal design and engineering had to be worked out by Mr. Burnham in consultation with Mr. Gottlieb, who, however, resigned in August, 1891.

In the spring of that year the work of preparation in Jackson Park commenced. This in itself was a gigantic labor. At the time when it was handed over to the exhibition executive, excepting for a small reclaimed portion, it was a wholly unreclaimed marshy tract, with a scanty vegetation of scrub oak. To obtain the necessary levels, 1,500,000 cubic yards of earth had to be obtained from some source and distributed over different parts of the park. This necessity rendered the introduction of extensive waterways and lakes inevitable, because the only means of obtaining the material required in some places was to excavate it from others. Messrs. Olmsted & Co. quickly learned how to turn this necessity to useful account, and the waterways of the exposition grounds will be one of their chief attractions. The problem that was presented for solution to the executive in the spring of 1891 can perhaps be best described in Mr. Burnham's own words:

"It was necessary that the vast area of Jackson Park should be reclaimed, and in twenty months transformed from a desolate waste into a park highly improved and embellished with all that skilled designers

* This paper (lately read in abstract before the Society of Arts, London) was illustrated by a large number of lantern slides, most of which were prepared from photographs kindly supplied by Mr. C. D. Arnold, official photographer of the exhibition.—From the *Journal* of the Society.

could suggest; that upon the stately terraces a dozen or more palaces of great extent be constructed, and that they be supplemented by over 200 other buildings, some of which are almost of the importance and size of the main structures; that great canals, basins, lagoons, and islands be formed; that extensive docks, bridges, and towers be constructed. It was necessary that a standard of excellence be obtained which would place the work upon an equality with the monuments of other ages—it meant, in short, that an organization be quickly formed which would associate together the ablest architects, painters, and sculptors of the world. Many of the great problems to be solved were new, no precedent having been established for the guidance of those assuming this great responsibility."

4. *Available Space.*—It is not too much to say that all this has been done, and, indeed, the promises of the engineers and architects have been more than fulfilled, for at the date of the dedication ceremonies in October last, nearly all the buildings were practically completed as regards constructive detail, leaving little but surface decoration to be done, and for the first time in the history of exhibitions, the buildings were open to exhibitors to install their exhibits six months before the date of the opening, the work of installation having commenced on the 1st of November last. The main buildings cover an area of more than 5,500,000 square feet, or over 123 acres; smaller and less important buildings still under construction occupy 1,155,000 square feet, or about 26 acres; State buildings occupy about 420,000 square feet; foreign buildings about 300,000 square feet, concession buildings 1,000,000 square feet. So that the total area of all the buildings in the exhibition grounds is no less than 190 acres. As regards the actual available space for exhibits, Director-General Davis places it at about 3,000,000 square feet, and it will be interesting to examine for the moment into the claims made by foreign countries for this space, because that will afford some indication of the interest shown by the world in the Columbian Exposition. Foreign countries have, we find, applied for 2,500,000 square feet of space out of the 3,000,000 square feet available, or 85 per cent. of the total.

American exhibitors on their part have asked for 5,000,000 square feet, so that the total amount of space demanded has been no less than 7,500,000 square feet—that is to say, that the largest exhibition which has yet been attempted must have been nearly twice its present size to have satisfied the claims of exhibitors. Surely nothing more convincing can be furnished than these figures, to prove the popularity and future importance of the World's Columbian Exposition. It being impossible to satisfy these demands, the work of restriction had to be severely carried out both for home and foreign exhibitors, and this in every department. The director-general has followed the rule common on these occasions of dividing available space almost equally between home and foreign exhibitors; to the former 1,300,000 square feet have been allotted, which is little less than half the total space available, and only a little more than half that asked for. The remaining 1,700,000 square feet is divided among the exhibitors of the United States, and as, since the expiry of the date for receiving applications, further demands are being constantly made, the space available is sufficient to satisfy only one-fourth of the demands, and this proportion appears to hold good in most departments.

5. *Executive Staff.*—A few important changes have taken place since last year in the *personnel* and executive of the exhibition administration. The chief of these changes are as follows: The president of the exhibition, the Hon. T. W. Baker, resigned the arduous and responsible position last summer, and has been succeeded by Mr. Higginbotham, one of the partners in the famous firm of Marshall Field & Co., of Chicago. Mr. William Prettyman, a well-known English artist, and chief of the department of color, also resigned early in the summer. He was succeeded by Mr. Francis D. Millett. Much more recently Mr. Robert S. McCormick, who had long and ably filled the position of American representative of the exhibition in England, was compelled to resign on account of urgent private affairs; Mr. McCormick was assisted by Commander W. Bainbridge Hoff, of the United States Navy, a gentleman detailed to England last spring by the American government for that purpose. The following is a list of the principal engineers and architects employed in the design of the buildings and grounds:

Mr. D. H. Burnham, chief engineer and chief of construction.

Messrs. F. L. Olmsted & Co., landscape architects.

Mr. Richard M. Hunt, New York, architect of Administration Building.

Messrs. Adler & Co., Chicago; Transportation Building.

Messrs. McKim, Mead & White, New York; Agricultural Building.

Mr. W. L. B. Jenny, Horticultural Building.

Mr. George B. Post, New York; Manufactures and Liberal Arts Building.

Mr. Henry Ives Cobb, Chicago; Fisheries Building.

Messrs. Peabody & Sterns, Boston; Machinery Hall.

Messrs. Burling & Whitehouse; Choral Building.

Messrs. Van Brunt & Howe, Kansas City; Electrical Building.

Messrs. Holabird & Roche, Chicago; Stock Ring and Pavilion.

Mr. S. S. Beman, Chicago; Mines and Mining Building.

Mr. Charles B. Attwood, Chicago; Fine Arts Building, Music Hall, and Casino, railway terminal station, guards' stations, fire stations, balustrades, bridges, etc.

The chief engineers of departments under Mr. Burnham are: Mr. R. Graham, assistant chief of instruction; Mr. Frederick Sargeant, mechanical and electrical engineer; Mr. E. G. Nourse, engineer of railroads; Mr. William S. MacHarg, engineer of water supply, sanitation, and fire protection; Mr. J. W. Alvord, engineer of grades and surveys; Miss Sophia G. Haydon, architect of the Women's Building. As already stated, all construction works have been carried out in the office of Mr. Burnham.

6. *Alterations in Plan of Exhibition.*—The alterations in the general plan of the exhibition are insignificant since I explained their arrangement to this meeting a year ago, and consist chiefly in the filling in of details. The plan of the terminal station, to which visitors will be conveyed from the city, is definitely settled and is practically complete; its location is that originally decided upon, at the back of the Administration Building. The space for warehouses, in which the empty packing cases of exhibits will be stored, is also decided upon. It is situated outside the exhibition grounds, adjoining the agricultural space, and alongside the railway station yard, where very extensive sidings are provided. The open space at the back of the Agricultural Building, reserved for stock and similar exhibits, has been considerably encroached upon by additional small buildings; the sheds are now larger and more numerous; the stock pavilion at the back of the covered gallery connecting the Agricultural and Machinery Buildings also occupies a good deal of ground. The concert halls at the eastern end of the great basin and adjoining the lake have now taken the definite form shown in the plan published in a recent issue of the Society of Arts *Journal;* they are connected by a long covered gallery of considerable architectural pretensions. The north side of the ground at the back of the Fine Arts Gallery is crowded with the buildings of the different States, and the space between the front of that gallery and the Fisheries Building is also being rapidly covered with the pavilions and offices of foreign nations. On a spare piece of ground between the Transportation and Horticultural Buildings, a Choral Hall has been erected, and numerous stations are being constructed along the line of the electric railway. These constitute the only important changes that have been made in the plan during the past year. The whole extent of the Midway Plaisance, a mile in length, is entirely taken up with allotments. Most of this space will be occupied by attractions—largely Oriental—from foreign countries; but there will also be a number of specially American exhibits and entertainments.

7. *Communication Within the Exhibition.*—As already said, there will be in all 190 acres of buildings filled with exhibits. The fatigue that must necessarily be incurred by the visitor by merely walking through these buildings may be easily imagined. And it is not only the extent of such a promenade that causes fatigue, but the fact that the attention is attracted at every step by some object of interest, and in order to gain even a superficial idea of the contents of the buildings, considerable feats of pedestrianism must be accomplished. Assuming that one-half of the total area is occupied by passageways, and that these on an average are 20 ft. in width, the total length of such promenades would be about 50 miles; add to this that in the best ventilated buildings the presence of vast crowds, especially during the summer months, produces very unfavorable atmospheric conditions—it will be remembered that on many occasions the Machinery Hall in Paris was almost unbearable—and it will be conceded that the visitor who proposes to make himself thoroughly acquainted with the Columbian Exposition will have before him a task of no small magnitude. Although the buildings are placed so close together that at the present time there appears room for the erection of no more on Jackson Park, still the distances to be traversed in going from one to another are very considerable. The frontage on the lake from north to south is nearly two miles. The greatest depth is not far short of a mile; the Midway Plaisance, which forms an extension from Jackson Park, is a mile in length. Two causes will probably contribute largely to an unusual amount of activity on the part of visitors. The cost of living in Chicago during the period of the exhibition will undoubtedly be great, and will therefore check the tendency of visitors to prolong their stay. The price of admission having been fixed at 2s., will not unlikely have the effect of reducing the number of visits paid by each person, and the labor of seeing the exhibition will therefore be harder, because more concentrated. In Paris, when the exhibition was, so to speak, at the doors of the people; when the ordinary price of admission was never more than 10d., and frequently fell as low as 3d., the Champs de Mars formed a delightful pleasure ground for millions who could repeat their visits day by day.

8. Under the very different conditions that will exist at Chicago, means of communication between the different buildings and with all parts of the grounds will become an absolute necessity. This has been thoroughly understood, and is being provided for as far as possible by the authorities. Canals having a length of 2½ miles have been laid out within the grounds, and a very large fleet of small boats will be at the disposal of passengers. These boats will in all cases be driven by storage batteries, which will be charged at different electric stations provided for that purpose. They will be of three classes: Express boats, making the round trip without any stops; local boats, stopping at stations connected with every building; and private boats, hired by the hour, like gondolas, but certainly not at the same rate. In addition to this means of transport, an electric elevated railway will run around the grounds. It will commence at the back of the Agricultural Hall, and running outside the Machinery Hall and its annex, will pass behind the Transportation, Horticultural, and Women's Buildings, where there will be a station for the Midway Plaisance; then up to the extreme northern boundary of the grounds, to accommodate the group of State buildings, and southward to the group of Art Galleries, the district of foreign pavilions, the Fisheries and Government Buildings, and the Naval Exhibit. Here, making a loop, it returns by the same course, until it joins, in another loop, the line at its commencement at the back of the Agricultural Hall. The total circuit made by this railway is over five miles, and as throughout its whole course it lies within the exhibition grounds, its value to visitors will be at once appreciated. The third means of transport is so novel and ingenious that it deserves some detailed description. Although the pier that forms an extension of the great central court into the lake, where it serves as one arm of the harbor constructed for the smaller class of naval exhibits, appears insignificant upon the plan, it is none the less of considerable length, especially after a hard day's work and under a burning sun, and doubtless many thousands of visitors returning homeward by the steamers which will ply between this pier and the city, will gladly avail themselves of the means of transportation which is to be laid down upon the pier. This is the "movable" sidewalk, and the pedestrian can step upon it at any time, and then be carried forward without further exertion. When he arrives at the end of his journey he can step off with equal facility. The principle upon which this means of locomotion is based is as follows: An endless platform of convenient width, and placed either level with the road or a few inches above (or on an elevated staging as the case may be), is constantly driven at a very low rate of speed—say at two miles an hour; upon this platform any one can step without inconvenience and be carried forward upon it. Beside the traveling platform is another of convenient width also traveling constantly, but at a higher speed of perhaps four miles an hour. This increased speed, it will at once be seen, is, relatively to that of the first platform, only two miles an hour, so that the passenger can step upon the faster platform from the slower, and double his speed without any inconvenience. A third and similar platform alongside the second would increase his speed to six miles, and so on. The inventor of this ingenious system claims that by the arrangement speeds of ten or twelve miles an hour can be arrived at, and that more passengers can be accommodated by it than on any other method that can be devised. Seats are provided on the various platforms for the accommodation of travelers, who will have to pay a uniform fare for any distance, on quitting the railway. There appear to be at first sight certain difficulties in the way of collecting the fares upon this line, but no doubt these will be got over with the same ingenuity that has devised the movable sidewalk.

9. The Midway Plaisance will, undoubtedly, be one of the most crowded portions of the exhibition, and, as it is a mile in length, some means of conveying passengers on an extensive scale are necessary. The system proposed for this purpose is one which attracted considerable attention in Paris during the year 1889. It is known as the Giffard Water Railway, and consists of an elevated track, on which are laid very heavy, broad, flat rails. Below the track, and along its center, is laid a water main, with hydrants, terminating in nozzles, rising from it at intervals. The carriages have no wheels, but rest on shoes which bear upon the rails. When it is desired to set these carriages in motion, water is introduced between each shoe and the rail, and at such a pressure that the train is entirely waterborne. Propulsion is effected by a series of water jets issuing from the nozzles before spoken of, and which are opened and closed automatically, as the train passes over them. It is needless to point out that considerable volumes of water and high pressures are necessary to drive such a train at moderate speeds. Great things are claimed for this system by the inventors; the merit of novelty may be fully conceded to it; and its practical value will, doubtless, be well tested at the exhibition.

10. *Transport of Visitors.*—The considerable distance between Jackson Park and the city involved the necessity of solving a problem of vital importance, and of a very great magnitude. The vast crowds who are expected to visit the exhibition daily will have to be conveyed to and from it with the least inconvenience to themselves, and with the greatest possible dispatch. Bringing visitors to Chicago from all parts of the country, and taking them away again, is another problem of no small magnitude, but this is one with which the exhibition authorities have nothing to do, and which may be safely left in the hands of the railroad companies that possess terminal facilities in or in connection with Chicago. Relating to this subject it may be mentioned that all excursion trains bringing passengers to the exhibition will discharge and receive them at the terminal station within the grounds, and will not enter the city at all. One means of communication that will exist between Chicago and Jackson Park will be the street railways, chiefly cable lines; the capacity of these lines is now being very largely increased, and will be still further extended by the first of May. There will also be a steamboat service running between a pier on the city water front and the exhibition pier in Jackson Park. It is intended that these vessels shall be large and numerous enough to deal with 15,000 passengers an hour. This means of communication will be very pleasant in fine weather, and sufficiently expeditious. Hired vehicles, especially Hansom cabs, will supply a limited means of communication; but, although the tariff in Chicago is comparatively moderate, this method of reaching the exhibition will hardly be a popular one. One of the chief means of communication will be the new elevated railroad, built by the Illinois Central Railroad Company. This line, which will be of very considerable capacity, will doubtless form one of the most efficient means of dealing with the traffic. Finally, there is the existing line of the Illinois Central Railroad Company, that starts from its terminal station on the city front and runs almost close to the grounds. In ordinary times it consists of six tracks, two of which are reserved for suburban traffic. These are now supplemented by four other lines exclusively for the exhibition: two of these will be used for express service, and the other two for stopping trains. The disadvantages inseparable from the working of service lines in crowded cities will be avoided as far as possible, and the traffic will be worked entirely on the block system; by this means the safety of the public in the streets and of those using the trains will be provided for. The great crowd which flocked to and from Jackson Park on the occasion of the recent dedication ceremonies was a severe test to the scarcely completed lines of communication. The local accounts differed widely as to the way in which the work was done, some of the newspapers claiming a complete success, while others reported something little short of failure. Probably the truth lay between the extremes, and there appears little danger of the extensive preparations being made breaking down after the exposition opens, although they will certainly be exposed to constant and excessive strain, especially during the hours of concentrated traffic.

11. *Fire Protection.*—Naturally every possible arrangement has been made to prevent the outbreak of fire in any part of the exhibition, and to subdue it in case a conflagration should take place. The exhibition authorities have been in close communication with a group of fire insurance companies, and a total insurance of $4,500,000 has been effected on the buildings. It was under the supervision of the insurance companies' officers that the fire system has been laid out. This system comprises appliances for ready means of access to every part of each building. Mains are laid

all over the grounds, with hydrants at frequent intervals, and the water pressure will be sufficiently great to throw an ample stream over the highest structures. The installation in the grounds consists of three steam fire engines, and connections with four of the city fire stations, of 20,000 ft. of hose, 960 fire extinguishers, and 2,750 fire pails. It is probable that this service will be nearly doubled before the opening of the exposition. In addition to the foregoing, a floating fire engine, the Fire Queen, has been recently launched. The boat is 65 ft. long, 16 ft. beam, and 6 ft. deep; her pumps will throw 1,500 gallons of water per minute to a height of 300 ft. The fact that the grounds are intersected with canals will enable this floating fire engine to be brought to any part with little delay. There will be 350 hydrants distributed over the 27 miles of water mains in the grounds. These mains are connected with one of the present city pumping stations, which can concentrate a supply of 34,000,000 gallons daily into the exhibition, and they will be supplemented by the pumping station within the grounds, which will have a daily capacity of 12,000,000 gallons. A large and efficient fire brigade is kept constantly on service, so that every possible precaution has been taken to avert any danger from this source.

12. *Department of Publicity.*—Among the several novel and ingenious features connected with the organization and arrangement of the World's Fair, a few words should be said about the Department of Promotion and Publicity. The special object of this department, which was established quite early in the history of the exhibition, has been to disseminate information, and to attract attention to the fair in all parts of the world. Major Moses P. Handy, the chief of this department, has recently supplied some very interesting statistics about the work done under his supervision. The department was organized in December, 1890; its first object was to overcome indifference and prejudice that existed abroad, and to make known the aim and scope of the great undertaking. Organized communication was first of all established between the department and the press of the United States, and in fact of all newspapers throughout the world. Articles, written in more or less glowing terms, explaining the purpose and importance of the exhibition, the remarkable suitability of Chicago and its site, and the advantages to be derived by exhibitors and visitors, were scattered broadcast throughout the world; of course the largest editions of these articles were published in English, but translations in French, German, Spanish, Portuguese, Swedish, Danish, and Italian were also sent out wholesale. In answer to these preliminary appeals, some 2,000 newspapers and other publications placed themselves in communication with the department, to which a flood of periodical literature steadily set in. For a considerable period the department was the only source in America whence information could be obtained, and while, as may be expected, those newspapers that limited themselves to reprint the items furnished them spoke uniformly in glowing terms of praise about the exposition, it is also worthy of note that but very little hostile criticism was offered. It should also be placed on record, in justice to Major Handy, that, with the unlimited opportunity and temptation which he had to circulate highly colored and exaggerated statements about the future importance and magnitude of the exhibition, everything which has been issued from his department has been fully justified by results. In the course of a few months the work of publicity grew to very large dimensions, until at the beginning of the present year some columns of printed information were sent each week to no less than 23,509 addresses in the United States; in addition to this, 13,846 similar communications were forwarded every week to foreign addresses, distributed among seventy-five different nations and colonies. On the other hand, the list of newspapers, daily and weekly, copies of which poured into the department at Chicago, numbered no less than 15,000; on an average each of these papers was supplied with exhibition official literature to the extent of 60,000 words a month, more than half of which came back as reprints into the department. These reprints were all classified and pasted up in enormous albums, which, of themselves, would form an interesting exhibit, and bear admirable testimony to the industry of Major Handy and his staff; not, however, that all these cuttings were collected in the department; on the contrary, "clipping bureaus"—to quote an expressive Americanism—all over the United States, were employed to collect and forward every item published about the exposition. The average number of letters and other mail packets posted per day in Chicago from this department is about 9,000, and it is stated that the work is increasing even at the present time. Another important branch of labor connected with the Bureau of Promotion and Publicity has been the preparation of more serious and high class articles upon the exhibition, for publication in magazines, encyclopedias, etc., and most of the small outline woodcuts which have familiarized the world with the general outward appearance of the principal buildings have also emanated from this department. As to the future, I cannot do better than quote Major Handy's own words: "Up to the opening of the exposition, and for some time hereafter, probably the department will send out to the press articles calculated to create a desire on the part of the people to visit the exposition, to inform them how best to reach Chicago, and avail themselves of its accommodations. It will endeavor to furnish intending visitors with all information they may need to enable them to do the Fair and Chicago with comfort, pleasure and the best advantage." All this, however, will form a small part of the duties which lie in Major Handy's immediate future. "The department is about entering upon the task of preparing, editing, revising and superintending the publishing of the official guides and the official catalogues of the exposition. This involves an immense amount of careful, painstaking labor. The department is already engaged in the collection of material for the official history of the exposition to be published by the government. This is likely to be in proportion about equal to the 'Encyclopædia Britannica,' and must contain much technical and statistical matter." It is quite needless to observe that the active and successful prosecution of all this work has been attended with a very large outlay; the results, however, that have been obtained appear fully to justify the expense. Such a stupendous organization for advertisement would of course have been wholly unnecessary for any International Exhibition held in Paris, London or New York, but the organizers of the World's Fair fully realized from the commencement how much the world at large, and even their own countrymen, stood in need of education about the city of Chicago and its resources, and how difficult it would be to make any one realize the scale of magnificence on which the exhibition was planned and has been carried out.

Probably nothing has contributed so much to a popular understanding of the extent and beauty of the exhibition as the large colored plates that have been issued by the Department of Promotion and Publicity; some of these plates represent the principal buildings, but the most important is a birdseye view of Jackson Park. Although their production must have been very costly, they have been distributed with a lavish hand all over the world, and they prove conclusively that in this particular branch of art printing Chicago can hold her own against any city in Europe.

13. *Building Materials.*—The materials which enter almost exclusively into the construction of the buildings are steel and iron, timber and fibrous plaster; this last named was used on a large scale and with great success at the Paris Exhibition of 1889. All the elaborate architectural decorative effects are produced in this material, and it may be readily imagined how large a staff of skilled art workmen have been employed. Statuary, moulding, and miscellaneous ornaments have been made on the grounds, although sculptors and modelers have been kept busy, not only in the United States, but also in Europe. At first this art work was produced in a special atelier, but as soon as the Horticultural Building was sufficiently advanced it was converted into an art workshop of magnificent proportions. Especially beautiful will be the monumental fountain of the American republic, executed by McMonnies, of New York, and referred to elsewhere.

The foundations are almost in all cases of the true Chicago type—that is to say, they consist of broad platforms, whose areas vary with the weight they are to carry, placed at suitable intervals, and entirely independent of each other. The nature of the ground renders this arrangement a desirable one, but whereas in the permanent buildings of Chicago these foundation platforms are constructed of steel beams and concrete, in the temporary buildings on Jackson Park timber is substituted for steel, and the concrete is chiefly omitted. In preparing these foundations the ground is excavated to the desired depth, and leveled to receive a close planked platform of the requisite size; on this platform heavy timbers are piled in tiers at right angles to each other, the whole being bolted together, and when the necessary height is reached the foundation is finished by close planking laid to receive the superstructure, whether timber or iron. In some few instances, such as the Administration Building, piles have been driven beneath the main supports of the great rotunda, but the foundation just described may be accepted as the general type. Within the space inclosed by each building, similar foundations are laid at frequent intervals to carry the flooring, and it may be mentioned in this place that very great advantages, as regards expedition in erecting the buildings, were obtained by finishing the floor of each before the heavy superstructure was commenced. A firm and heavy platform was secured by this means, and the amount of damage done to the floor was not so great as might be imagined. The exterior walls of the buildings (with the exception of the Fine Arts) and most of the internal framing are of timber; as regards the exterior, the main framing is covered with light timbers nailed diagonally in place, with narrow spaces between them to serve as a key for the plaster. The external and internal surfaces are carefully rendered upon the coarse internal body of plaster, and the enrichments, prepared as already described, are then added. In the majority of cases timber stanchions serve to carry the iron and steel roofs; in one or two instances, notably in the Fine Arts Building, and in the Mines and Mining Buildings, iron columns are used; in others, such as the main roof of the Manufactures Building, and in the Electricity Building, the arched ribs start direct from base plates laid upon the timber foundations; in other cases, again, such as the Administration Building, the dome of the Horticultural Building, and the Government Building, the standards form a continuous structure with curved ribs supporting the dome. In all cases the leading characteristic of the iron and steel work is its remarkable lightness. It is also noticeable that the same types of construction run through not only every building, but in all the different members in each building, from the vast ribs of the Manufactures Building to the light purlins and small connecting girders. The type is that of an open lattice, the dimensions of which are cut as fine as prudence will allow, while any apparent deficiency in strength is fully compensated by elaborate systems of cross bracing. It must be remembered that, although these buildings have to serve only a temporary purpose, the material employed in their construction will be called upon to fill other permanent uses, and that during the eighteen months of their existence at Jackson Park they may have to withstand strains as great as if they were intended to last for twenty years. The engineers of the exhibition had therefore to design work which should really be of a permanent character. There is no doubt that the special and uniform type of construction they have adopted contributed very largely to the rapid execution of the iron work by the various contractors intrusted with its execution. Such contractors in the United States enjoy a well deserved reputation for turning out work of high character with great rapidity. An illustration of this recently came within my notice. A certain railway in a South American republic was urgently in want of some extensive bridge work to complete a line and convert it into a revenue bearing property. Tenders were asked for from English and from American bridge constructors, the urgency of speedy delivery being insisted on in each case. The English tenders—which, by the way, were somewhat higher than the American—undertook delivery in eight months; the American constructors offered to deliver within eight weeks. Needless to say the latter firm obtained the order, and filled it. This little illustration explains other things besides the rapidity with which the iron work of the Columbian Exposition has been completed. Of course the various buildings were erected by different contractors, so that the whole work could be pushed forward simultaneously; and as three shifts of men were constantly employed, every hour in each twenty-four was utilized. The Art Building, on account of its more valuable contents, has been constructed with a special view to its safety from fire. In this case steel is employed throughout, with outer and inner walls of brickwork. It may be mentioned here that in all cases the specifications in which the tenders for the iron work were prepared are as rigid and carefully drawn as for any first class and permanent building. The exterior and interior surfaces of all buildings are covered with paints of fire-resisting compositions, and the vast areas to be covered suggested to the fertile American mind some device more rapid than the brush, by which the paint is applied by a spreading nozzle, through which it is forced by the agency of air compressed by an electric motor.

It may now be convenient to describe rapidly the distinctive features of the various main buildings; these were referred to prospectively in the paper read last year before the society; and those remarks may be supplemented now by some facts drawn from the actual work done.

14. *Administration Building.*—The Administration Building is placed at the west end of the great court formed by the long range of facades of the principal halls; it faces eastward, and looks toward the lake. The architect is Mr. Richard M. Hunt, of New York, President of the American Institute of Architects. Its estimated cost is £110,000, and its dimensions are very large. It occupies an area of more than 250 ft. square, and the general design consists of four corner pavilions, 84 ft. square, connected by four walls, in which are the main entrances. The inclosed space forms a rotunda, 120 ft. in diameter and 220 ft. high. The four great portals, one on each side, are 50 ft. wide. The public will be admitted to various exterior galleries, the highest of which is 200 ft. from the ground within the dome. The corner pavilions will be occupied as offices for the various departments of the administration, but the building will not contain exhibits. Immediately in front of the Administration Building will be a monumental fountain, designed by Mr. Frederick McMonnies, of New York. This great fountain, which by night will be brilliantly illuminated with electric light and colors, is placed in a basin 150 ft. in diameter. The lip of the basin is about 10 ft. above the level of the grand basin. In the center of this fountain will be a ship bearing a triumphal car, with a female figure of Progress seated thereon. The boat will be propelled by six heroic figures, wielding gigantic sweeps; these figures will represent the Arts and Sciences. A winged figure of Fame will be at the bow, and Time, represented by a heroic figure, steers the boat. The highest point of this group will be 35 ft. from the level of the basin, and the distance between the tips of the two sets of oars will be about 60 ft. Around the edge of this basin are sea horses leaping under their riders' blows. Ingenious sprays of water will form a mist and give animation to the fountain. A large cascade of water will pour from the lip of the basin, and pumps with a very large capacity will serve the fountain.

15. *Machinery Hall.*—The Machinery Hall, which is one of the great buildings in the central court, is 850 ft. long and 500 ft. wide, with an annex of 500 ft. by 550 ft.; the east front faces on the central court, and the north adjoins the Administration Building. Three main galleries occupy the length and width of the area; they are about 130 ft. wide, and are crossed in the center by a transept of the same width. The roofs of these galleries and transept are, in each case, semicircular, the height of springing of the arch being about 22 ft. from the floor level. Each rib is free to turn on three points—the two bed plates and a central point at the summit of the roofs. The ribs thus consist of two half arches, connected by a central pin and constructed of light iron lattice girders of the type already referred to, excepting at the base and the summit of the arch, where solid panels are introduced for the whole width of the rib, which is about 6 ft. At the intersection of the transept, the ribs of which cross those of the galleries at right angles, the former are so spaced as to serve as the base for the rectangular iron framework that rises above the top of the ribs and form the foundation for three flat domes of 130 ft. in diameter, rising to the height of more than 50 ft. above the ribs. By this arrangement the arched framework of the transept is removed, and its place is taken by the series of three domes, rising to about 130 ft. above the floor. The domes are circular in plan, and the space between the lower boundaries and the corners of the rectangular frame above spoken of, as resting on the arched ribs, is filled in with a flat roof. At each corner of the building is an entrance pavilion, surmounted by a domed roof, and in the center of the north and east sides there are large entrance porticos, flanked by towers 200 ft. high. Outside the arched galleries just described, and surrounding the building, are flat-roofed courts, framed in timber and sheathed with fibrous plaster.

These courts are in two stories, affording an extensive promenade on the ground floor and a large gallery space above. The longitudinal framework of the iron portion of this structure is very elaborate, and cannot be described in so brief a notice as the present; the roof is, to a large extent, covered with glass, and, so far as can be judged, the arrangements provided for lighting and ventilation cannot fail to be satisfactory.

The building was designed with a view to erecting it hereafter as a great railway station, to which purpose it can be admirably adapted. The construction of the annex calls for no particular comment, nor does that of the power station adjoining. This power station will form probably one of the most interesting parts of the machinery section, as it will contain the boilers, engines and dynamos for generating all the power required throughout the exposition—about 24,000 horse power. The various units of this station will constitute exhibits.

The adoption of electricity on a very large scale, for driving the machinery in motion, will be one of the new departures at the Columbian Exposition. It will be exclusively used in the annex, which is framed wholly

in timber; but in the main hall steam will be employed.

As in the Paris Machinery Hall, overhead rails will run from one end of the building to the other, and on these traveling platforms will be placed for the convenience of visitors. These platforms will be electrically driven.

16. The area of the Machinery Hall is 17½ acres, which is divided as follows:

	Square feet.
Main hall	425,000
Annex	269,990
Total	694,990

This area is not quite so large as that of the Machinery Hall and its annexes at the Paris (1889) Exhibition. As, however, it is hardly to be expected that foreign nations will require so much space for this class of exhibit in Chicago as they did in Paris, it might have been supposed that the space allotted to American exhibitors would have been sufficient for the purpose. This does not appear to be so, and, according to the report of Mr. L. W. Robinson, the demands for space are altogether out of proportion with what can be supplied. The statement that there are 17½ acres of floor space is in itself somewhat misleading, because from this total many important deductions have to be made. These deductions are approximately as follows:

	Square feet.
Stairways, restaurants, entrances, etc.	56,990
Foreign sections	175,000
Power plant for engines and dynamos	112,974
Engines for driving American exhibits	3,000
Deductions for aisles, avenues and passage ways	116,675
Total net space for American exhibits	220,351

It will be seen from the foregoing figures that the space available for American exhibits and machinery sinks into really insignificant proportions; that this is so will be a cause of deep regret and disappointment to those American manufacturers who will be unable to display their specialties with advantage, and also to the numerous foreign visitors, to whom the show of American machinery will be one of the principal attractions. It would seem, indeed, that unless some very extensive annexes be made to this building, the Machinery Hall will be a general source of disappointment, because it will be incapable of doing full justice to that branch of American industry which has made such prodigious progress during the last few years. Six months ago the applications for space represented more than four times the total amount availing, and the unsatisfactory problem which Mr. Robinson is called upon to solve is to satisfy exhibitors who require 900,000 ft. of space with one-fourth of that amount. Those who call to mind the American section in the Machinery Hall of the Centennial Exhibition, in 1876, will remember that it was densely crowded, and yet it covered an area of more than 100,000 ft. greater. It is true that on that occasion exhibits relating to electricity, to transportation, and to mines and mining were all grouped within the Machinery Hall, but in 1876 none of these classes occupied a great deal of space. At Chicago a vast building has been allotted to each of these groups, and the prospects are that they will be densely packed with exhibits. When the progress that has been made during the last eighteen years in mechanical arts is borne in mind, there is no reason for surprise that the demand for space is far greater than the supply, and it would almost appear as if the organizers of the exposition had lost sight of the fact that the pressure in this department will be unprecedented. Mr. Robinson, the chief of the department, writes at a recent date in a somewhat desponding tone as follows:

"Either three-quarters of the applicants must be left out, or cut down to one-fourth of the space applied for, or finally the chief of the department must take upon himself the responsibility of placing on the space available the representative firms who have applied, and eliminate the less consequential applicants. Thus the manufacturers of the country will suffer greatly by not being able to make as full a display of their products as they would otherwise be entitled to do, and there will be many strong and enterprising concerns who will not be represented. Unless additional buildings are provided, the whole brick and tile industry will not find a place, nor will fire engines and fire extinguishing apparatus secure a location. Besides these, heavy machinery, like drop hammers, steam hammers and machinery requiring fire for its operation, like forges, special boilers, gas and oil machinery, must be omitted."

17. *Agricultural Building.*—This building will be devoted to the exhibition of agricultural implements and processes, and of food products. It is 800 ft. in length by 500 ft. wide, and its facade has been planned to harmonize with those of the other buildings on the main court.

It is not a lofty building, its general cornice line being only 65 ft. above the ground; its general architectural features are a great rotunda forming the principal entrance, and four large corner pavilions connected by a lofty colonnade. The rotunda is 100 ft. in diameter and 130 ft. high; this rotunda is roofed by a flat dome heavily enriched with mouldings and color. Apparently the Agricultural Building is not well fitted for the effective display of exhibits. Two central galleries, 95 ft. in width, intersect each other on the longer and shorter axes of the building; these are roofed by iron trusses of the usual light construction, and being 75 ft. high, these two galleries will be extremely effective; the remainder of the space is, however, divided up into narrow spans of about 25 ft., with the exception of two of 48 ft., and as all these are wooden structures, with numerous and heavy posts to carry the roof, the general effect cannot be very satisfactory. The effect of size will be further interfered with by the numerous galleries, about 25 ft. above the ground, introduced into most of the narrow spans; it will probably be found difficult to light the interior of this building satisfactorily. But if the interior of the Agricultural Building should leave anything to be desired, the beauty of its exterior cannot fail to attract universal admiration. The whole internal space of this building will not be devoted to exhibition purposes. The agricultural interests in the United States are so vast that it was considered desirable to provide special accommodation for the various farmers' associations, which are very numerous and important. Accordingly, space has been reserved for a suite of committee rooms and information bureaus on the ground floor, while above is a spacious assembly room for agricultural congresses. The building does not represent by any means the only allotments for agricultural interests. There will be various annexes for dairy and forestry exhibits, saw mills, the leather industry, etc., and in this connection I am glad to say the London and Provincial Dairy Company, of which Mr. Watts is the managing director, is erecting a very beautiful pavilion, in which the most advanced processes and machinery of dairy farming will be represented. I, for one, shall be much disappointed if this exhibit does not take a front rank among all the similar industries of the United States.

A very large open area will be devoted to the exhibition of cattle, and there will be a great covered arena for the same purpose, while long rows of shedding will provide ample and suitable accommodation for live stock which will be brought to Jackson Park.

18. *Electricity Building.*—The chief external feature of the Electricity Building, which is 690 ft. long and 345 ft. wide, is a number of high and ornate towers, which are framed in timber, covered with plaster. Internally it possesses no very striking features, though the central aisle and transept are of considerable dimensions. They are 115 ft. wide, and the trusses carrying the roof are 112 ft. in height. These trusses are open braced steel work, starting from the ground with a vertical outer member for a height of 75 ft., while the inner member is curved almost from the floor line to the center of the truss overhead. Above the 75 ft. just mentioned the outer member is straight, and inclined to the maximum height of 112 ft. The trusses are placed 23 ft. apart, and the intersection of the nave and transept are made of diagonal ribs of the same character as the others. The rest of the building is covered with a flat roof, supported on deep timber trusses of 23 ft. and 66 ft. spans, the whole floor area on each side of the central aisle being broken up with timber columns placed 23 ft. apart. These all carry the upper gallery, while a certain number are extended to support the timber roof trusses.

The net space available for exhibits in the Electricity Building is 185,000 square ft.; of this 68,000 has been allotted to foreign countries, leaving less than 120,000 ft. for American exhibitors, apparently a very small and insufficient area for the proper display of an industrial science which has, during the last ten years, made such enormous strides in the United States. The principal groups will approximately occupy the following areas: Dynamic electricity, including station work, 40,000 square ft.; railways, 20,000; mining, 5,000; telephones and telegraphs, 7,000; power transmission, 6,000; miscellaneous, about 40,000 square ft. These spaces will be divided among 700 exhibitors, and there will be approximately 300 foreign exhibitors, bringing up the total in this building to 1,000. Collective exhibits will probably be more frequent in the Electricity Building than in any other part of the exhibition, so far as the American section is concerned: in this section there will probably be not more than 300 separate groups. This arrangement presents many advantages, one of which is economy of space, and that this was an absolute necessity is shown by the fact that the serious applications for space amounted to more than 500,000 feet, or nearly five times as much as could be given. One especially interesting feature in the American section will be a number of personal exhibits made by famous living electricians, who will in many cases conduct a series of experiments connected with their special lines of research in public during the course of the exhibition. Professor John P. Barrett is chief of the electricity department. He is specially qualified for this important position by much admirable work that he has done during the thirty years that he has served as electrician to the municipality of Chicago.

The Electricity Building must not be confounded with that devoted to the generation of power to be employed in lighting the buildings and grounds, and for the transportation services. This installation forms part of the machinery hall, and will be largely under the charge of Professor Barrett, who, speaking about this installation, says: "Electricity will light the entire grounds of all the exposition and all the buildings. By means of electrical power transmitted from a common center, all the machinery in all the buildings will be operated. Passenger and freight elevators in the large buildings will be operated by electric motors. The only passenger railway on the grounds will be electrical. The omnibus line of lagoon passenger boats will be operated by storage batteries. Ventilation by exhaust fans in the buildings will be conducted by means of electric motors. The spectacular and other fountains upon the grounds will be electrical. Other uses will be made of electricity in minor directions, and small motors will be made to operate an infinite variety of machinery in every department. In these directions Jackson Park will be in reality an immense electrical exposition.

19. *Mines and Mining.*—The architecture of this building is Italian Renaissance. In plan it is simple, and on each of the four sides of the building are placed the entrances, those of the north and south fronts being the most spacious and prominent. The building is 700 ft. long, and 350 ft. wide. To the right and left of each entrance inside, start broad flights of easy stairs leading to the galleries. The galleries are 60 ft. wide, and 25 ft. high from the ground floor, and are lighted on the sides by large windows, and from above by a large clerestory, which extends entirely around the building. The main front looks southward on the Grand Avenue, and northward on the lagoon and wooded island. The principal fronts display large arched entrances, richly embellished by sculptural decoration, emblematic of mining and its allied industries. At each end of these facades are large square pavilions, surmounted by low domes, which mark the four corners of the building, and lighted by large arched windows extending through the galleries. Between the main entrance and the pavilions are richly decorated arcades, forming an open loggia on the ground floor, and a deeply recessed promenade on the ground floor level, which commands a fine view of the lake, and inland to the northward and the great Central Court on the south. These covered promenades are each 25 ft. wide and 230 ft. long, and from them access is had to the building at various points. The loggias on the first floor are to be faced with marbles of various kinds and hues, which will be considered as part of the mining exhibit, and be so arranged as to have a marketable value at the close of the exhibition. The main fronts are 65 ft. high from the ground to top of cornice, and the main central entrances are 90 feet to apex of pediment. The two storied portion of the building, of which the gallery forms the upper part, extends entirely around the structure, and is 60 ft. wide. This portion is built of wood and iron combined. The great interior space thus inclosed is one story high, 630 ft. long, and 230 ft. wide, with an extreme height of 100 ft. at the center and 47 ft. high at the sides. It is spanned by steel cantilever roof trusses, supported on steel columns placed 64 ft. 6 in. apart longitudinally and 115 ft. and 57 ft. 6 in. transversely, thus leaving a clear space in the center of building 630 ft. long and 115 ft. wide, with two side divisions, 57 ft. 6 in. wide and 630 ft. long each, leaving the great central space encumbered with only sixteen supporting posts. The cantilevers are made with pin connections to facilitate erection. The inner and higher ends of cantilevers are 46 ft. apart, and the space between them is spanned by riveted steel trusses, with an elliptical lower chord. These trusses are so designed as to form a clerestory 12 ft. high, with vertical sashes extending the entire length of the central span, 630 ft., this span terminating at each end with a great glass gable setting back 60 ft. from the front ends of the building. The wide spacings of the cantilever necessitated an extensive system of longitudinal purlins of the riveted lattice type. A great portion of the roof is covered with glass. It may be of interest to state that the cantilever system, as applied to roofs, has not been used before on so large a scale. This building will undoubtedly be one of the most successful of the whole series for exhibition purposes.

20. *Transportation.*—This exhibition is the first at which a large and separate building has been set aside for exhibits relating to transportation; at all previous exhibitions, objects illustrating various means of transport have been found, but arranged in separate groups and various buildings as subsidiary classes. In no country has increased facility of transportation developed progress and civilization so rapidly as in the United States, and it therefore followed, almost as a matter of course, that a special department and a separate building should be assigned to it. But that this building should cover as much ground as the machinery hall at the Paris Exhibition of 1889, and that this vast area of 18 acres should be found wholly insufficient for the demand of exhibitors, is a surprising illustration of the interest taken in the subject, and of the determination of those interested to make as perfect a display as possible. The space required by foreign nations in this important department is set forth in the following list:

	Square feet.
Great Britain	65,748
France	65,748
Germany	40,000
Canada	15,000
Austria	10,000
Mexico	3,000
Spain	3,000
Russia	2,635
Belgium	5,000
Italy	1,500
India	1,000
Netherlands	1,250
Latin America	618
Total	214,499

American exhibitors have demanded 800,000 sq. ft., which is far more than can be granted, so that in this building, as in every other, a severe cutting down of applications must become necessary. But although so large an area is asked for, the actual number of American exhibitors is in this department only about 800. It is clear, of course, that exhibits of this class, as a rule, occupy a large average of floor space, and when it is stated that the American section will contain between 60 and 70 locomotives, the largest of them weighing nearly 100 tons, and that the exhibits of railway cars and wagons will include some hundreds of different types, it will at once be realized that the railway section of the Transportation Department must occupy a very large amount of room, and be on an unprecedented scale. Cars for street railways, for propulsion by horse power, steam, electricity, gas, and other motors, will also be very largely represented, and as it is intended that space will be provided to show these vehicles in operation, a special and large area is be set aside for this purpose. American railway companies are competing with each other in the extent and magnificence of their exhibits. One company alone has secured an acre of space, in which will be displayed every appliance connected with a first-class American railway. Other companies, while exhibiting their latest practice, will also show examples of their earlier appliances, so as to illustrate historically the development of their line. Road carriages of all kinds will also be shown by some in hundreds of examples. Transport by water will be illustrated chiefly by models, although full sized boats, and especially steam launches, will not be wanting. All the heavier exhibits in this department will be shown on the ground floor, but the extensive galleries will be occupied chiefly by the lighter appliances for transport, among which it is needless to say bicycles and tricycles will largely figure. In this latter group I think there is no doubt that the English will occupy a leading place.

21. One of the special features of the Transportation Department will be a series of historical exhibits, which it is hoped can be made very extensive and complete. This group will be enriched by many interesting objects from this country as well as from France and Germany, while the United States possess almost an equal number of the earliest illustrations of steam propulsion, both by land and by water. The country is also rich in exhibits of road vehicles dating from colonial times, and doubtless many of these will be found in the Transportation Building next year. At the same time special efforts are being made to induce the own-

ers of relics in Europe to lend them for exhibition. As far as possible, all the exhibits will be arranged in historical sequence, so as to show the gradual development of the various means of transportation. Speaking recently on this subject, Mr. Willard A. Smith, chief of the department, said: "There is assured, for the first time in history, a thoroughly international exhibition of transportation. It must be remembered that European railway machinery and appliances are so different from the American that, leaving the tariff out of the question, there is no market for them here. American vehicle builders are rapidly controlling the markets of the world, and American shipbuilding is just starting upon a career of new growth and extension. The inducement, then, for the European countries to make this kind of an exhibit was exceedingly slight. Their first response was, in nearly every case, that they would require no space in the transportation department." Subsequent considerations, however, modified this conclusion, with the result that all foreign sections are now of the extent given above, and Mr. W. Smith states that several important countries are now applying for space which it is quite impossible to give them.

(To be continued.)

MINERAL PRODUCTS OF THE UNITED STATES.

THE United States Geological Survey, J. W. Powell, director, David T. Day, chief of division of mining industries, has recently issued a valuable table showing the mineral products of the United States for the calendar years 1880 to 1891, inclusive, from which we make the following abstract for the years 1880, 1891:

Products.	1880.		1891.	
	Quantity	Value.	Quantity.	Value.
Metallic.				
Pig iron, value at Phila., l. t. (c)	3,375,912	$80,315,569	8,279,870	$128,337,085
Silver, coining val. (d), f. oz.	30,320,000	39,200,000	58,300,000	75,416,565
Gold, coin'g val. (e), f. oz.	1,741,500	36,000,000	1,604,840	33,175,000
Copper (f), val. at N. Y., lb.	60,480,000	11,491,200	295,810,076	38,455,300
Lead, val. N. Y., s. t.	97,825	3,782,540	202,406	17,609,322
Zinc, val. N. Y., s. t.	23,239	2,277,432	80,337	8,033,700
Quicksilver, val. S. F., flasks (g)	59,926	1,797,780	22,904	1,036,396
Nickel (h), val. Phila., lb	329,908	164,984	118,498	71,099
Aluminum, value Pittsburg, lb.	(i)		(j) 150,000	100,000
Tin, lb.			125,280	25,056
Antimony, val. S. F., s. t.	50	10,000	278	47,007
Platinum, val. (crude) S. F., t. oz.	100	400	100	500
Total value of metallic products		$190,039,865		$302,307,922
Non-Metallic (Spot Values b).				
Bituminous coal (k), l. t.	38,242,641	$53,443,718	105,291,721	$117,108,483
Penn. anthracite, l. t.	25,580,189	42,196,678	45,236,902	73,944,735
Building stone		18,356,055		47,294,746
Petroleum, bbls., (m)	26,286,123	24,183,233	54,291,980	32,875,188
Lime, bbls., (n)	28,000,000	19,000,000	60,000,000	35,000,000
Natural gas	(i)			18,000,000
Cement, bbls. (o)	2,072,943	1,862,707	8,222,702	6,680,951
Salt, bbls., (p)	5,961,000	4,829,566	9,987,945	4,716,121
Phosphate rock, l. t.	211,377	1,123,823	587,988	3,051,150
Limestone for iron flux, l. t.	4,500,000	3,800,000	5,000,000	2,300,000
Mineral waters, gal. sold	2,000,000	500,000	18,362,732	2,096,259
Zinc-white, s. t.	10,107	763,738		1,000,000
Potter's clay, l. t.	25,783	200,457	400,000	900,000
Mineral paints, l. t.	3,604	135,840	47,652	658,478
Borax, lb.	3,662,443	277,233	13,380,000	809,700
Gypsum, s. t.	90,000	400,000	208,125	628,051
Grindstones		500,000		476,113
Fibrous talc, s. t.	4,210	54,730	53,054	493,068
Pyrites, l. t.	2,000	5,000	119,320	358,880
Soapstone, s. t.	8,441	66,665	16,514	243,981
Manganese ore, l. t.	5,761	86,415	23,416	239,129
Asphaltum, s. t.	444	4,440	45,054	242,264
Precious stones		100,000		235,300
Bromine, lb.	404,690	114,752	343,000	54,880
Corundum, s. t.	1,044	29,280	2,247	88,430
Barytes (crude), l. t.	20,000	80,000	31,069	118,363
Graphite, lb.		(q) 49,000		110,000
Millstones		200,000		16,587
Novaculite, lb.	420,000	8,000	1,375,000	150,000
Marls, s. t.	1,000,000	500,000	135,000	67,500
Flint, l. t.	20,000	80,000	15,000	60,000
Fluorspar, s. t.	4,000	16,000	10,044	78,330
Chromic iron ore, l. t.	2,288	27,808	1,362	20,580
Infusorial earth, s. t.	1,833	45,900		21,988
Feldspar, l. t.	12,500	60,000	10,000	50,000
Mica, lb.	81,669	127,825	75,000	100,000
Ozocerite, refined, lb.	(i)		50,000	7,000
Cobalt oxide, lb.	7,251	24,000	7,200	18,000
Slate, ground, l. t.	1,000	10,000	2,000	20,000
Sulphur, s. t.	600	21,000	1,200	30,000
Asbestos, s. t.	150	4,312	66	3,960
Rutile, lb.	100	400	300	800
Lithographic stone, s. t.	(i)		(i)	
Total value non-metallic mineral prod.		$173,279,135		$356,216,615
Total value metallic products		190,039,865		302,307,922
Estimated value min. prod. unspecified (s).		6,000,000		10,000,000
Grand total		$369,319,000		$668,524,537

a. The results for 1889, with the exception for lime, cement, salt, zinc-white, borax, bromine, slate ground as a pigment, and rutile, were obtained through the eleventh United States census.
b. By "spot" value is meant value at the point of production.
c. "Long" tons are tons of 2,240 avoirdupois pounds; short tons are tons of 2,000 avoirdupois pounds.
d. $1.2929 per troy ounce.
e. $20.6718 per troy ounce.
f. Including copper made from imported pyrites, except in 1881, for which no returns are available for matte.
g. Of 76½ avoirdupois pounds net.
h. Including nickel in copper-nickel alloy, and in exported ore and matte.
i. Not reported.
j. Including aluminum alloys.
k. Including brown coal and lignite, and anthracite mined elsewhere than in Pennsylvania.
l. Not including lime in barrels, limestone for iron flux, or grindstones.
m. Of 42 gallons.
n. Of 200 pounds.
o. Of 300 pounds for natural cement, and 400 pounds for artificial Portland.
p. Of 280 pounds net.
q. Value of the crude product.
r. Including cobalt oxide in ore and matte.
s. Including fire clay, common brick clay, terra cotta, building sand, glass sand, limestone used as flux in lead smelting, limestone in glass making, iron ore used as flux in lead smelting, tin ore, iridosmine, nitrate of soda, carbonate of soda, sulphate of soda, native alum, mineral soap, strontia, and pumice stone.
l. t. means long tons.
s. t. means short tons.

THE MANUFACTURE OF LIQUORS AND PRESERVES.*

By J. DE BREVANS, Chief Chemist of the Municipal Laboratory of Paris.

CHAPTER II. *(Continued.)*

SECTION VII.—INFUSIONS, DECOCTIONS, AND MACERATIONS.

INFUSIONS are prepared by throwing boiling water upon the plants or other materials to be treated, and as soon as the liquid is charged with the aromatic principle it is removed from the solid residue.

Decoctions are prepared by boiling the material to be treated for a certain time in water. Digestion is the name given to the action of the liquid which is allowed to act upon the material for a certain length of time at a temperature of from 35° to 60° C.

Maceration is an infusion made with a cold liquid. The operation is continued for the time necessary to dissolve the aromatic principles which the materials contain.

SECTION VIII.—JUICES.

The juices of fruits and vegetables are used in the manufacture of sirups and in a number of liquors which have sirups for bases. Juices are extracted from the leaves, fruits, stems, roots, and seeds of plants by a very simple process. The material is pulped in a mortar and submitted to pressure. A small hand press (Fig. 37) is usually used.

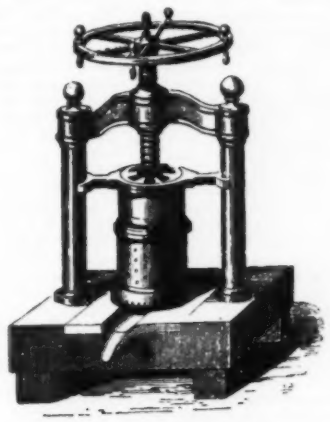


FIG. 37.—HAND PRESS.

Clarification of Juices.—The juices when they come from the press must be clarified. The operation is performed in several ways, but heat is generally used.

Clarification by Fermentation.—This method of clarification is based on the transformation of sugar into alcohol by fermentation, which insures also the preservation of the juice. The juices are placed where the temperature varies from 20° to 25° C. until it is transformed into wine. Forty-eight hours is usually sufficient. When the fermentation is finished, the liquid is filtered.

Clarification by Filtration.—This process is by no means perfect, because there are a number of soluble materials which will bring about changes in the liquid later.

Clarification by Heat.—The juices are heated to about 80° or 90° C. and a solution of white of egg is added. The juice is then skimmed and filtered.

Clarification by Tannin.—M. N. Basset highly recommends the process of clarification which uses a 10 per cent. solution of tannin, which eliminates the albumen.

Preservation of the Juice.—The juices are preserved in heavy bottles.

1. Preservation with Sulphur.—The bottles are filled and a space equal to two fingers is left between the top of the liquid and the mouth of the bottle, and a piece of candle wick dipped in sulphur is burned in the neck of the bottle.

2. Preservation by the Appert Method.—This is the most convenient method of preserving juices. The

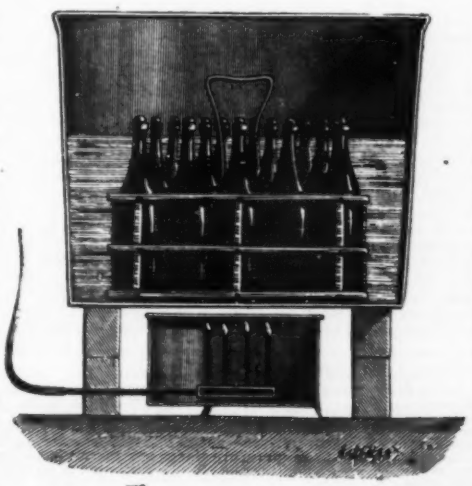


FIG. 38.—APPARATUS FOR HEATING SIRUPS.

clarified juices are bottled in stone or glass bottles and corked and wired; they are then carried in a rack to a hot water kettle (*bain marie*) of sufficient size to allow the liquid to cover the bottles (Fig. 38). The water is carried to the boiling point, and after a few seconds the source of heat is removed and the water is allowed to cool down, when the bottles are removed.

The following are receipts:

Juices of Huckleberries, Barberries, Cherries and Grapes.—Crush the fruit and pass the pulp through a horse hair sieve; crush the marc and unite and carry to the cellar. After 24 hours of fermentation, filter and preserve. The juice of cherries is better when a mixture of black and red cherries is used.

Orange and Lemon Juice.—Remove skin and seeds, crush the pulp and press, and mix with rye straw, washed and cut fine, to assist the separation of the juice. Clarify by repose, filter and preserve.

Quince, Apple and Pear Juice.—Peel and rasp the fruit, taking care not to touch the seeds. Press the pulp, mixed with rye straw, washed and cut fine. Clarify by repose, filter and preserve. The quinces should be fully ripe.

Raspberry Juice.—Crush the fruit and press the marc. The liquid is allowed to repose for one or two days, after which it is filtered. One-fifth the weight of red cherries is sometimes added to the raspberries.

Pomegranate Juice.—Remove the skin and hard partitions. Pulp with the hand and press. Let the juice clear by repose, filter and preserve.

Gooseberry Sirup.—Squeeze the pulp through a horse hair sieve and press. Let the juice repose for 48 hours, filter and preserve. One-fifth by weight of cherries can be added if desired.

Peach, Apricot and Prune Juice.—Clean and pit the fruit, crush the pulp and mix with rye straw, washed and cut fine. Press and put in the cellar for two days, filter and preserve.

SECTION IX.—SIMPLE SIRUPS.

Before describing the manufacture of liquors it is necessary to describe the substances which form their base and their process of manufacture.

Alcoholic liquors are formed essentially of alcohol, sugar and various aromatic principles and sometimes a coloring matter composed of various substances and intended to render the liquor agreeable to the eye as well as the taste.

1. Alcohol and the various aromatic principles have already been treated. 2. Sugar [as the classification of sugar in this country is entirely different from that of France, the section on sugar is omitted]. Only a good quality of sugar should be used. 3. Glucose is used only in inferior liquors.

Preparing Sugar.

The various degrees of concentration of sugar are known under various names in French which have no meaning when translated, so that the French names are retained.

Sucre au Lessé.

This is a variety of boiled sugar and is made as follows: Boil the sugar until, when a drop is held between the fingers, when the fingers are separated they will be connected by a thread of sugar.

Sucre au Perlé.

Repeat the preceding experiment, using a more concentrated sirup. If the thread is of the same consistence as the sirup, it is said to be *perlé*.

Sucre au Soufflé.

If the concentration is continued, when a little is dipped up by a skimmer, shaken lightly and blown at the same time, small bubbles will form. The sugar is then said to be *soufflé*.

Sucre à la Plume.

Continue to boil, and after dipping the finger in water and then in the sugar, and lastly in water again, the sugar forms a feather-shaped mass

Sucre au Casse.

A little later the sugar becomes very thick, and after dipping the fingers in water, then in the sugar, the sugar hardens so that it breaks on separating the fingers.

Sucre au Caramel.

This name is used in English and French to denote the condition when the sugar under the action of prolonged heat turns yellowish brown and gives off a powerful odor. It is used by confectioners and liquor manufacturers for coloring. [This classification is very crude, and leaves much to be desired.—Ed.]

Simple Sirup.

This solution is one of the most important which the liquor manufacturer has to prepare. The name simple sirup is given to a solution of sugar in water concentrated until it has the density of 1·26 (30° Baume) when it is boiling and 1·32 (35° B.) when cold. This corresponds to 1,000 parts of sugar and 530 parts of water. The sirups of sugar are prepared by heat, in the following manner:

White sugar	1 k. 700 grm.
Distilled water	1 k.

Crush the sugar put it in a basin with the prescribed quantity of water, heat to the boiling point and filter. Simple sirup is also prepared cold, as follows:

White sugar	1 k. 800 grm.
Distilled water	1 k.

Dissolve the sugar in the water and filter.

Coloring Materials.

Coloring matters are added to liquors to render them agreeable to the eye. They are harmless if non-poisonous materials, such as cochineal, saffron, and caramel, are used. The coloring matters that are considered dangerous to health are the salts of lead, copper, aniline derivatives and certain plants, such as aconite.

Red Colors.
Cochineal.

Boil	
Water	1 l.
Cochineal, pulverized	65 grm.
After boiling ten minutes, add	
Pulverized alum	15 grm.
Powdered cream of tartar	15 grm.

* Continued from page 14196, SUPPLEMENT No. 888.

Continue the boiling until the materials are completely dissolved, let it cool, and add ½ l. of alcohol (85°). Filter through cotton, and place in bottles.

Cudbear.

Cudbear	400 grm.
Alcohol (85°)	1 l.

Macerate for five days, agitate several times a day, decant the liquid, treat in the same manner the residue by using a new quantity of alcohol for the same time; unite the two liquids and filter.

Red Sandal Wood.

Wood rasped	30 grm.
Alcohol	1 l.

Macerate for 24 hours, press and filter. This coloring matter can only be used in those liquors which are unaltered by it.

Brazil Wood.

Bois de Brésil au Bois de Fernambouc.

Brazil wood (fine)	250 grm.
Alcohol (85°)	1 l.

Macerate for four days, press and filter.

Yellow Colors.

Saffron Yellow.

Saffron, pulverized	100 grm.
Water	1 l. 50 c. c.

Boil a portion of the water and pour on the saffron. Cover and leave it to macerate until the infusion is cold; when cold, press. On the residue throw the rest of the water, preferably at the boiling point, then allow it to cool in a closed vessel; press and unite the two liquids. Add 750 c. c. of alcohol (85°) and filter. Persian and Avignon berries are also employed to color liquors yellow, mixed together with or without saffron. This produces the best color for Chartreuse.

Caramel.

Heat in a deep round basin 1 k. 400 grm. of molasses until the point of caramelization is reached, stirring constantly. Remove from the fire for a moment and throw in small quantities, with stirring, into ½ l. of water heated to 85°. Filter.

Blue Color.

Indigo Blue.

Dissolve 10 grm. of finely pulverized indigo in 100 grm. of sulphuric acid at 66°. Place the indigo in a glass or stone vessel and add the acid, stirring until dissolved. Dilute with 3 l. of water and neutralize with 120 grm. of finely powdered chalk, stirring with care. The sulphate of indigo remains in solution, while the calcium sulphate is precipitated. After repose, decant and filter. Add to the color 30 per cent. of alcohol (85°).

Violet Color.

The violet color is seldom used. It can be made, however, by an ammoniacal solution of cochineal, or by a mixture of cudbear red and blue.

Green Color.

The green color is obtained by a mixture of blue with yellow; for example, indigo with caramel or saffron, or by means of a solution of chlorophyl in concentrated alcohol. This color is very fine, but has the grave fault of being destroyed very rapidly in liquors of less than 70°.

The plants most generally employed in the manufacture of a green color are dry lemon balm mint (*mélisse*), infused for eight days in 100 grm. per l. of alcohol (86°), dry nettles and spinach. When it is necessary to prepare a fine solution of chlorophyl a certain quantity of alcohol is carried to the boiling point and it is thrown on the leaves, extracting the coloring principles. The solution can be used at once.

(*To be continued.*)

THE VOLCANIC ROCKS OF SOUTH MOUNTAIN IN PENNSYLVANIA AND MARYLAND.*

By GEORGE H. WILLIAMS.†

1. *Object of this Paper.*—It is the object of the present communication to announce the identification of an extensive area of very ancient volcanic rocks, which compose an important part of the South Mountain, south of the Susquehanna River. The brief preliminary description of these rocks, which is all that can now be attempted, will, it is hoped, suffice to show that the hitherto accepted theory of their sedimentary origin has been based on a misinterpretation of the facts which they exhibit.

The rocks in question preserve abundant and convincing evidence—both structural, chemical, and petrographical—of their original character and genesis. At the same time, they show various phases of alteration by recrystallization and dynamic agencies, which render them valuable for the study of many problems of metamorphism.

South Mountain rises about fifteen miles west of Harrisburg and extends in a great sickle-shaped curve to the Maryland line. Here it divides into two parts, known as Catoctin Mountain and the Blue Ridge, which diverge at a small angle and inclose the triangular Middletown valley, north of the Potomac.

During the past summer the writer devoted considerable time to mapping the volcanic rocks of this region and to collecting suitable material for laboratory study. This has at present only been fairly entered upon, so that subsequent communications, giving more detailed results, may be expected.

2. *Supposed Sedimentary Origin of the South Mountain Volcanic Rocks.*—As far as is known to the writer, volcanic rocks have not hitherto been definitely described as such in the Appalachians. The rocks here under consideration have long been known to geologists, but they have before, with the exception of a few of the most massive greenstones, been generally regarded as of sedimentary origin.

Professor Henry Rogers, in 1858, speaks of South Mountain southwest of the Susquehanna as embracing "a singularly small amount" of igneous rock. He alludes to the cleaved greenstones as "dark green slate," and to the acid porphyries and felsites as "highly metamorphic primal slate." He continually contrasts the highly altered slate and the unaltered sandstone,* although, in reality, one rock is scarcely more changed than the other.

Philip Tyson, in his first report as State agricultural chemist, made in 1860, speaks of the sandstone of South Mountain as Potsdam, and says that it contains fossilized stems of plants. He also says: "A slate, varying in color from gray to brownish and greenish, is ranked as an argillite but portions of it assume a marked talcose appearance, especially in Catoctin Mountain, where it has been much disturbed and altered by proximity to intrusive rocks. These last consist of amphibolites (trap), porphyries, amygdaloid, serpentine and epidote."†

In 1877 appeared the results of Dr. Persifor Frazer's studies of South Mountain. He regarded it as composed essentially of a westerly (older) portion, consisting of various modifications of a quartz-conglomerate (Mountain Creek rock), and an easterly (younger) portion, composed of orthofelsite, interbedded with hydromica and chloritic schists.‡ Regarding the origin of these latter rocks, which, like the conglomerate, were placed below Rogers' primal sandstone, Dr. Frazer made the following statement in 1877,§ repeating it two years later:‖ "The porphyry, which carries the copper of this region, shows no character of igneous action, but occurs in coarse and thin beds, more or less disintegrated, and in some localities reduced almost to the state of kaolin."

Dr. T. Sterry Hunt announced to the American Association for the Advancement of Science, in 1876, that he had identified petrosilex or halleflinta in South Mountain, which he had examined, with Dr. Frazer.¶ Dr. Hunt's concurrence in 1879 with Dr. Frazer's opinion above cited, and his constant use of the term *bedded pretrosilex*, sufficiently indicate that he regarded these rocks as sedimentary. He, however, correctly compares the South Mountain rocks with others in Missouri, the Lake Superior region, Eastern Massachusetts, Maine and New Brunswick, since shown to be volcanic, although he saw in this similarity only evidence of their "Huronian" age.

The nearest approach to a recognition of the South Mountain rocks in Pennsylvania as volcanic was made by Mr. J. F. Blandy, who described the copper-bearing rock in 1879 as *amygdaloid trap*, and correlated it with the similar flows near Lake Superior. The acid felsites, however, were regarded by Mr. Blandy as slate.**

In his recent final volume on the geology of Pennsylvania, Professor Lesley follows in the main Dr. Frazer's classification of the rocks of South Mountain. Although he considers that the sandstone probably represents the "Huronian" of Logan and Murry, he says it is impossible not to compare it with Walcott's Cambrian system. The supposed overlying feldspathic felsite series (orthofelsite of Frazer) Lesley estimates as 6,000 feet in thickness, and everywhere speaks as though he regarded it of sedimentary origin.††

The cause of the prevailing misconception regarding the volcanic rocks of South Mountain is not difficult to find. Their accompanying accumulations of tuff beds and breccias, and the fact that they are generally cleaved parallel to the great structure planes of the mountain, have all been readily interpreted as indications of stratification and conformity. The cleavage dip in the sandstone has often been mistaken for bedding, while the thin jointing and slaty structure of the lavas, though a secondary feature, have seemed to geologists not very familiar with recent volcanic rocks sufficient proof of sedimentary origin.

In spite of great age and some alteration, however, the volcanic rocks of South Mountain have preserved all the essential characteristics of our recent rhyolites and basalts in such perfection that the proofs of their real nature are, to the student of comparative petrography, overwhelming, while to all who will candidly examine them they must be at least convincing.

3. *Petrographical Character.*—Approximately 175 square miles of the area of South Mountain is occupied, between Mount Holly and the head of the Middleton valley, with volcanic rocks. These belong to two types which exhibit sharp contrasts of color, composition and weathering. One type is inclined to tints of red, pink, blue, or purple; is acid in composition; generally porphyritic, and weathers into thin slabs. The other type is almost invariably of a green color; basic in composition; frequently amygdaloidal, and weathers into rough, angular blocks. The rocks of the first type have been called felsite, orthofelsite, porphyry, or petrosilex; those of the second, trap, greenstone, chlorite slate, or epidote slate. In view, however, of the perfection with which these rocks have preserved the most characteristic features of their modern equivalents, there is no reason why they should not, like them, be termed *rhyolites* and *basalts*. The insignificance of mere age as a factor in rock nomenclature is now so fully recognized that we may with propriety employ the names of our recent lavas for rocks of any geological horizon, when we can prove beyond doubt their identity.

It is, of course, to be expected that many rocks of intermediate character will be found within this volcanic area. Since the petrographical and chemical study has, however, only begun, and since the contrast above noted is so well defined, the distinction of two types may at present be regarded as sufficient.

(*a*) *The Acid Rocks, Rhyolites.*—The rocks of the acid type occupy somewhat more than two-thirds of the volcanic area of South Mountain. They occur in dikes and flows, forming a body of great thickness; they are accompanied by ashes, tuffs and breccias; they are usually porphyritic, though not always so; they exhibit the characteristics of recent glassy and half-glassy rocks—flow structures, perlitic structure, lithophysæ, spherulites (in masses, in layers and in chains), axiolites, pumice, amygdaloids, etc., etc.—in hardly less perfection than the specimens which Professor Iddings has so admirably described from the Yellowstone Park.

These structures are preserved, in spite of the recrystallization of the entire rock substance into a fine mosaic. They are therefore most apparent in hand specimens, especially when brought out by weathering; or under the microscope, they are better seen in ordinary than in polarized light, as was the case with the old glass breccia, recently described by the writer from the Sudbury region.*

The following is an analysis of a rhyolite specimen from the Gladhills road, near the Bigham copper mine, on the north side of Pine Mountain, made by Mr. C. Hanford Henderson, of Philadelphia, and published in 1884.† This is a quite typical rhyolite analysis. When compared with analyses of our most recent acid lavas, the iron may seem a little high and the alumina a little low, but on the whole the close agreement is a surprise.

SiO_2	73·62
Al_2O_3	12·22
Fe_2O_3	2·08
FeO	4·03
CaO	0·34
MgO	0·26
Na_2O	3·57
K_2O	2·57
Ign.	0·40
Total	99·09

The macroscopic features of the rhyolite are the best proofs of its true nature, for weathering brings out on the surface of the rock each delicate detail. In this way we discover every characteristic of glassy rocks, though there is no glass now remaining. A specimen five inches long is covered with lithophysæ as perfect as any the Yellowstone can furnish. Their delicate petals are a pale pink, while the base has weathered white. With a lens the radiating and minutely fluted, concentric structure can be traced distinctly. The delicate lines of flow structure are displayed on the weathered surface of a specimen which in its interior is a homogeneous, dark purple felsite. On other specimens these flow lines are even more sinuous.

At some localities the rhyolite is crowded with spherulites. A large specimen was found north of the junction of Copper Run with Tom's Creek. Here the spherulites make most of the mass and have no regular arrangement. They have the size of large peas. In other cases the spherulites are of smaller size and more sparsely distributed. They are then not infrequently arranged in layers as described by Iddings in the Yellowstone obsidian.‡ One specimen from Raccoon Creek (No. 143) shows small but very perfect gray spherulites distributed, singly, in layers or in large aggregates through a black base which was once probably obsidian. In appearance it is not unlike the well-known specimens from the Lipari Islands.

Another specimen shows a very common arrangement of spherulites. Here they occur in single layers, which, in cross section, appear like chains, bent more or less out of their normal horizontal position by the flow motion of the magma.

The individuality of these spherulites is preserved, though they are so merged into one another that they approach the axiolitic structure. This structure is so frequent that it has doubtless helped confirm the idea that the felsite and porphyries were stratified. It seems to be quite independent of the presence or absence of phenocrysts in the rock.

Still another characteristic which the South Mountain rhyolites possess in common with many recent lavas is what we may call the *eutaxitic* structure.§ This consists of the close intermingling of two portions of the magma which, on account of some slight differences in chemical composition or hydration, show a marked contrast in color. The two portions may be, for instance, black and white, pink and blue, or red and gray. They mingle so as to produce in some cases an irregular mottling; in others a complex series of interlacing bands which bring out the flow structure in a striking manner. Specimen No. 145 from Raccoon Creek shows small black areas resembling shreds of glass, embedded in a pink base which, on a weathered surface, appears snow white.

Amygdaloidal structure, representing old vesicles more or less elongated by motion in the viscous mass, is much less common in the acid than in the basic rocks. Fine examples of it were, however, found at the Bigham copper mine; along Raccoon Creek and at the eastern end of the Jack's Mountain tunnel (Nos. 20, 147 and 7). As a microscopic feature this vesicular structure is still more common. Perlitic parting, so characteristic of glassy rocks, may be detected macroscopically in many felsite specimens.

The microscopical characters of the South Mountain rhyolites are far too varied to be described in a brief paper like the present. It must suffice to say that, in spite of the recrystallization of the substance, we still find in great perfection all the essential features of the most recent acid lavas. Corroded and skeleton pheno-

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* Read before the National Academy of Sciences, November 2, 1892.—From *American Journal of Science.*

† The writer is under great obligations for many of the facts contained in this paper to Miss Florence Bascom, who has mapped in great detail one of the most diversified portions of South Mountain, near Monterey, Pa. She has collected a large material upon which she is now at work at the Johns Hopkins University, and her results, to be published in due time as a thesis, will go far toward furnishing detailed proof of the general conclusions here set forth.

* Geology of Pennsylvania, vol. i, pp. 203-5, 1858.

† First report of P. T. Tyson, State Agricultural Chemist, to the House of Delegates of Maryland, January, 1860, pp. 34, 35 (cf. also p. 18). In his second report (1862, p. 70) he gives further particulars regarding Catoctin Mountain. He says "a vast mass of epidotic trap, five miles wide, was forced up from below in a state of fusion. This embraces a mass of chert (rhyolite) 3,000-4,000 feet thick." He describes the trap as carrying metallic copper, and regards it as the cause of the elevation of the mountain sandstone.

‡ Report of Progress in the counties of York, Adams, Cumberland and Franklin. Second Geol. Surv. of Penn. CC for 1875. Harrisburg, 1877, p. 288.

§ "Copper Ores of Pennsylvania." Polytechnic Review, vol. iii., p. 170, April 28, 1877.

‖ Trans. Am. Inst. Min. Engineers, vol. vii., p. 338, 1879.

¶ Proc. Am. Assoc. Adv. Sci., 1876, pp. 211, 212, and Second Geol. Survey of Penn., vol. E, 1878, p. 193.

** "The Lake Superior Copper Rocks in Pennsylvania." Trans. Am. Inst. Min. Engineers, vol. vii., p. 331, 1879.

†† A Summary Description of the Geology of Pennsylvania, by J. P. Lesley, State Geologist, vol. i., p. 146, 1892.

* Bull. Geol. Soc. Am., vol. ii, p. 138, 1891. Ann. Rep. Geol. Surv. Can. for 1889-90, F, p. 75, 1891.

† "The Copper Deposits of South Mountain," by C. H. Henderson. Trans. Am. Inst. Mining Engineers, vol. xii., p. 90.

‡ Obsidian Cliff, 7th Ann. Rept. U. S. Geol. Surv., p. 276, Plate xviii., 1888.

§ Fritsch and Reiss: Tenerife, p. 414, 1868. Rosenbusch: Die Massigen Gesteine, 2d Ed., p. 625.

nocrysts of quartz, micropegmatitic intergrowths of quartz in feldspar phenocrysts,* and phenocrysts broken by the flow movement. In the ground mass we find spherulitic tuffs, axiolites, elongated vesicles filled with quartz, trichites and globulites in great variety, which bring out each detail of flow structure. All the particulars of microscopic structure call for extended study and description. For the present purpose, however, which is merely to establish the character of these rocks, what has been said must suffice.

In mineralogical composition the South Mountain rhyolites are quite uniform. When phenocrysts are present, the most abundant are alkali feldspar. Quartz in rounded bipyramids is alway to be found with the feldspar under the microscope, although it is not so often apparent to the unaided eye. In only a single instance (No. 257 D, from the head of Miney run) has any ferro-magnesian constituent as yet been detected. In this case biotite is abundant as an original mineral. The groundmass of the rhyolites is for the most part a quartz-feldspar mosaic of varying grain, much of which is the result of devitrification and recrystallization, though some of it is also probably original microgranite.

Attention has been called by Tyson,† Hunt,‡ and Frazer § to the beauty of the South Mountain porphyries, and to the fact that they are so susceptible of a high polish as to make them valuable for decorative purposes. Many of them closely resemble the famous *porfido rosso antico* of Egypt, which is largely used by the lapidaries of Rome.

(*b*) *The Basic Rocks, Basalts.*—The basic lavas of South Mountain occupy an area about one-half as large as that covered by the acid ones. They reach their maximum development near the State line, where, along the southern edge of Pennsylvania and for a considerable distance into Maryland, they form the entire width of the volcanic belt. North and south of this main body, the basic rocks or greenstones are everywhere met with as narrow bands intersecting the rhyolites and following the general trend of the mountain. These bands differ much in their width, but seem to be most developed along the eastern flanks of Green Ridge and Piney Mountain.

These rocks have been more generally sheared into slates than the acid lavas. The chemical alteration which has gone on in them is also in general greater. Still large masses of the basic rocks have been but little altered and remain quite massive. These, which are locally known as "copper rock," are the only members of the volcanic series whose igneous origin has been heretofore conceded. They are for the most part very fine grained, vesicular flows, whose original structure is still so well preserved that they may with propriety be called basalts.

The following analysis, also by Mr. C. H. Henderson, of a massive greenstone from the Bechtel copper shaft, Russel mine, is published by Dr. Frazer.‖ This is a normal basalt analysis, indicating as little chemical change in the basic rocks as the one given above does in the acid rocks.

SiO_2	41·280
Al_2O_3	18·480
Fe_2O_3	9·440
FeO	8·200
CaO	7·040
MgO	7·486
Na_2O	3·523
K_2O	2·208
Ign	2·740
Total	100·397

Basic volcanic rocks never exhibit so great a variety of structure forms as characterize the more acid rhyolites. The South Mountain basalts are usually homogeneous, dark to pale green masses which rarely show any microscopical phenocrysts and whose most constant feature is amygdaloidal structure. These cavities vary greatly in size, shape, and abundance. They are often elongated by flow motion in the lava and are now filled with a number of secondary minerals, the most abundant of which are epidote, chlorite, quartz, and zeolites. Traces of original glass or spherulitic structure (variolite) have not yet been detected in the basalts.

The mineral constituents of basic rocks are more subject to alteration than those of acid ones. It could not be expected that basalts so ancient and so vesicular as those of South Mountain would escape all change, but it is a surprise in many cases that this change has been so small.

The ferro-magnesian constituents have always altered to epidote, chlorite, or serpentine, but the structure is frequently preserved in its minutest detail. Under the microscope the ophitic network of feldspar laths is still fresh, and the delicate twinning as distinct as in a recent lava. The form of the basaltic magnetite, of the olivine phenocrysts and of the interstitial pyroxene is also plainly visible, while the arrangement of the feldspar microliths among the oval vesicles clearly indicates the motion of the still viscous mass.

The cut gives two types of the basaltic structure. The one on the left shows skeleton phenocrysts of olivine and a fine-grained, ophitic groundmass.

Both have large amygdules which are either oval or of irregular shape, and filled with different minerals.

(*c*) *Pyroclastic Deposits, Tuffs, and Breccias.*—As is generally the case with large accumulations of surface eruptions, the South Mountain lavas are accompanied by extensive deposits of pyroclastic material. This includes coarse flow and tuff breccias, pumiceous bombs, and banded accumulations of fine volcanic ash. Like the massive rocks, this fragmental matter is both acid and basic in composition.

The most striking and important area of acid tuffs covers about a square mile in the Buchanan Valley, at the eastern base of Piney Mountain, two miles north of the Chambersburg turnpike. Here the rock is a breccia whose component fragments vary from two or three feet in diameter to the finest ash. All sizes, shapes, and colors are heterogeneously mingled, and the result bears a superficial resemblance to the well-known triassic breccia (Potomac marble," "calico rock") of the Frederick Valley. The material in this case, instead of being limestone, is entirely rhyolite, and exhibits remarkable variety of structures and colors. Both flow and tuff breccias occur here, while a portion of the mass has been sheared into a quite fissile slate. Similar acid tuffs, though of less striking appearance, occur at many other points (Raccoon Creek, Monterey, old Furnace road, etc.), and will doubtless continue to be discovered as the examination of the region proceeds.

Fragmental deposits consisting wholly of basaltic material abound along the Western Maryland railroad near Monterey, and farther south. The finer cementing material is in these almost always altered to epidote. It is also not uncommon to find coarse breccias consisting of both the acid and basic types of rock, but a careful search has thus far failed to discover any fragments of sandstone in these pyroclastic beds.

4. *Geological Occurrence and Relations to the Sandstone.*—No evidence is necessary, beyond the petrographical characters above described, to establish the igneous and volcanic nature of the South Mountain rocks. Additional evidence of a purely geological kind is not, however, wanting. The vicissitudes through which these ancient rocks have passed, and their present inadequate exposure, tend to obscure their original relationships. Nevertheless dikes may be seen at various points, especially at the western end of the railroad tunnel on Jack's Mountain, where an amygdaloidal red felsite cuts the massive and schistose greenstones. Futher exploration will doubtless bring to light many similar occurrences. Successive flows are not now easy to separate, but the amygdaloidal and fluidal structure of the rocks indicates that they must have been extruded in this form.

The age of the South Mountain volcanics and their relations to the sandstone in which Mr. Walcott has recently identified the lower Cambrian fauna are points of great interest. The hypothesis of the Pennsylvania geologists that the greenstones and felsites lie above the sandstone is evidently incorrect. It may, however, be regarded as an open question whether the volcanic rocks represent a much older horizon, which was already eroded before the sandstone was deposited, or whether they were, in part at least, contemporaneous with the sandstones.

The entire absence of sandstone as inclusions in the lavas, as well as in all the accumulations of pyroclastic material; the observations of Keith, Geiger* and Walcott,† that the sandstone lies flat or in synclinals;

Left Half.—Basalt with skeleton olivines, ophitic structure, fresh feldspar. Amygdules filled with quartz and chlorite. Railroad, east of Monterey, Pa.

Right Half.—Somewhat coarser grained basalt. Amygdules filled with zeolites and quartz grains. Railroad, east of Monterey, Pa.

and the sections made by Miss Bascom across Monterey Peak, Pine Mountain, Jack's Mountain, and Haycock, near Monterey, all indicate that the sandstone is altogether above the volcanic rocks, and that it has been only sporadically left by erosion on the east side of the mountain in Pennsylvania. In Maryland the volcanic rocks are flanked both on the east and west by sandstone. No alternations of relatively thin beds of sandstone and lava have thus far been observed. The contacts of the sandstone above the porphyry on the old tapeworm railroad southwest of Maria's Furnace, and above the greenstone in the Jack's Mountain railroad tunnel, are both admirable exposures, but both seem to be thrust planes and are not contacts of original deposition.

The South Mountain volcanic rocks therefore become, not merely in their petrographical character and richness in metallic copper, but also in their stratigraphical position, comparable with the Keweenawan or Nipigon series of Lake Superior.

5. *Chemical Alteration and Metamorphism.*—Extensive chemical changes, involving devitrification and the formation of new minerals, have gone on in all the volcanic rocks of South Mountain without destroying the original structures. In other cases, where there has been movement and shearing, the same rocks have lost both their original minerals and structures by a process of complete matamorphism. The results are more or less perfectly foliated schists and slates, whose origin can be positively traced to the volcanic rocks, and whose present form can be shown to depend upon the intensity of the dislocation to which they have been subjected.

The chemical changes, which have not affected the massive character of the rocks, consist of the formation of new minerals to accord with the altered physical conditions. These have, as a rule, merely replaced the former minerals so as to leave the original structure of the rock intact. In the basic rocks the new minerals are epidote, fibrous green hornblende, chlorite, serpentine, iron oxide, and, to less extent, calcite and quartz. Of these by far the most important is epidote. Indeed, the conditions for the formation of this substance must have been exceptionally favorable, as it has everywhere been produced in great abundance. Some of the finer material, like volcanic ash or breccia cement, is wholly altered to this mineral. It is also the most common filling of the amygdules.

In the acid rocks there has been a complete recrystallization of all glass into a fine quartz feldspar mosaic, which, however, still exhibits the original structures. The conditions favorable to epidote formation are manifest in these rocks in the presence of large amounts of the manganese epidote (piedmontite). This rare mineral is so abundant and occurs in such interesting relations that it will soon be made the subject of a special communication.

The manner in which these compact, fine-grained rocks have been reduced along lines of shearing into fissile slates is most instructive. This is accompanied by the abundant production of sericite in the acid, and of chorite in the basic rocks, while the phenocrysts and all original structures are obliterated. Amygdules, where present, usually remain as flattened spots, either lighter or darker than the rock. Several suites of specimens have been collected to illustrate this process, but the account of its details must be reserved for a future paper.

That the large area of fissile, pale green schists occurring between Pine Grove Furnace and Laurel Forge consists of sheared felsite may be seen from the following analysis, made for commercial purposes, by A. S. McCreath. This rock, which is locally known as "soapstone," is extensively used at Pine Grove Furnace in the manufacture of brick. Its alkalies were not determined.

SiO_2	74·970
Al_2O_3	13.860
FeO	2·700
CaO	0.220
MgO	1·230
Alkalies	?
Ign	2·058
Total	95·038

6. *Comparison with Other Regions.*—The comparative rarity of very ancient volcanic rocks in America, as compared with Great Britain* and other parts of Europe, is doubtless due to their not having been recognized, rather than to their actual absence. The opinions entertained by Hunt of rocks like those of South Mountain have greatly retarded, in this country, the appreciation of their true character. Still, they are well known on Lake Superior and in Missouri through the writings of Irving† and E. Haworth;‡ Wadsworth § and Diller ‖ have described them in Eastern Massachusetts, Shaler ¶ in Maine, and the northern continuation of this same belt has been made known by the Canadian geologists, Bailey, Matthew, and Ells, in New Brunswick.** Bell has also recently described similar rocks in the Sudbury region.††

Similar areas are easily recognizable in Canada and Maine from the writings of Hunt, Jackson, and Hitchcock, in spite of the fact that they are not properly interpreted. Volcanic rocks have not before been clearly identified in the Appalachians, but if attention is called to them they will doubtless be recognized at many other points.

ETHER AS A MENSTRUUM IN MEDICATION BY THE SKIN.‡‡

By Sir JAMES SAWYER, M.D., London, F.R.C.P., Consulting Physician to the Queen's Hospital, Birmingham.

MAY I especially invite the attention of pharmacists to the advantages of ether as a menstruum, for the preparation of remedies which are designed to act through the skin? Confirmed and extended as my views have been by experience in practice, I venture to think the proposals I made to the medical profession, two years ago, concerning this use of ether, indicate a practical advance in our remedial resources which promises further useful application, both in human and in comparative therapeutics.§§ Not every official compound "for outward application only" can be accredited with percutaneous energy. Until ethereal tinctures and liniments were used, we were accustomed in medical practice to present many remedies and many different preparations to the skin, with the view of producing remote or local effects, or both, in the form of compounds very ill designed for their special purpose. The official formulæ of outward applications include emplastra, various liniments, of alcoholic, saponaceous or oleaginous composition, and certain fatty unguents. Of these medicaments for enepidermic use the oily liniments and the ointments, because of their easy admixture with the sebaceous secretion of the human skin, are probably the most active. I am afraid the structure of none of the fourteen plasters of the British Pharmacopœia is such as to permit the absorption of its active ingredients by the skin. The body of an officinal plaster is made of litharge in union with oleic, margaric and stearic acids, or of wax, of lard, of frankincense, of resin, of soap, of suet, and of some fixed oils, in various combinations. "Neither a plaster so formed," as I wrote in one of my former papers upon this subject, "nor a solution in alcohol of the active principles of drugs is a scientific medicament for enepidermic employment and percutaneous action, if we have regard to the structure and physiology of the human skin." In practice it is found that there are at least three separate obstacles to the absorption of a medicine through the skin; namely, the fatty sebaceous secretion of the skin, the epidermis, and insolubility of the drug. So far as I know, ether is the best menstruum for the solution of many remedies for local use through the skin. It is a good solvent of the active principles of many drugs, and it is a ready solvent of the fatty con-

* J. P. Iddings; loc. cit., p. 274 and Plate xv.

† First Annual Report, 1860. Appendix, p. 3.

‡ Proc. Am. Assoc. Adv. Science, 1876, p. 212 (compares them with the Elfdalen porphyries).

§ Second Geol. Survey of Penn., Vol. CC. p. 285.

‖ "Hypothesis of the structure of the copper belt of South Mountain," Trans. Am. Inst. Min. Engineers, vol. xii., p. 82. 1883-4.

* Bull. Geol. Soc. America, vol. ii., p. 155; plates 4 and 5.

† This number of this Journal.

* Sir A. Geikie: Anniversary Address, Quart. Jour. Geol. Soc., vols. xlvii. and xlviii., 1891-1892.

† Monographs U. S. Geol. Survey, v., 1883; and Bulletin, No. 62, 1890.

‡ Am. Geologist, vol. i., p. 280, 1888, and Bull. Missouri Geol. Survey, No. 5.

§ Bull. Mus. Compar. Zool. Cambridge, vol. v., No. 13, p. 282.

‖ Ibid., vol. vii., No. 2, 1881.

¶ This Journal (III.), vol. xxxii., p. 40, 1886. Ann. Rep. U. S. Geol. Surv., vol. viii., p. 1043, 1889.

** Ann. Rep. Can. Geol. Surv., 1877—DD. and 1879—80 D.

†† Ibid., for 1889—90 F, 1891.

‡‡ From the *Pharmaceutical Journal and Transactions*, October 15, 1892, p. 301.

§§ See the *Lancet*, May 17 and June 20, 1890, and my "Contributions to Practical Medicine," of the same year.

stituents of the sebaceous secretion of the skin. An ethereal liniment supplies the most intimate application of a remedy to the bare dermal surface. Dr. Lauder Brunton has written: "It would appear that the fat of the skin, as well as the epidermis, presents an obstacle to the absorption of substances in solution; but when they are applied in such a form that they can readily mix with the sebaceous matter of the skin, they are tolerably readily absorbed; as, for example, when they are used in the form of ointment. . . . They are also when they are dissolved in ether, and especially in chloroform, even when simply painted over the surface. Alcoholic solutions are not absorbed when painted in this way." Chloroform has many disadvantages, but ether is an excellent agent, for use either as a monstruum, in tinctures for external employment, or as a simple solvent for the preparation of a liniment.

I have proposed and used several ethereal tinctures for dermal employment; namely, of belladonna (tinc. bellad. ætherea), of capsicum, of iodine and of menthol. I expect physicians and pharmacists will find other useful developments of ethereal preparations as remedies applied to the skin.

THE AMERICAN "CROWBAR AND SKULL CASE."

A CORRESPONDENT of the *Medical and Surgical Reporter* writes us: While in Boston last summer I saw this skull and bar, and made the inclosed hasty sketch.

An article in *Stone* (vol. v., p. 493, 1892), giving an account of the wonderful accident, prompts a description of this case, which has gone on record as the most remarkable in the annals of physiology and surgery, while prominent physiologists are still unable to explain how the thing could have happened without causing death.

Phineas Gage, aged twenty-five years, a native of Lebanon, N. H., was foreman of a gang of men, who were employed in blasting rock at Cavendish, Vt. Gage had never had a day's illness from childhood, and was, as far as could be determined, perfectly healthy.

At the time of the accident, on Sept. 13, 1848, he was charging a drill hole for blasting and sat on a shelf of rock just above, but a trifle to the right of the hole, as he faced it. The powder and fuse were in position and he was in the act of tamping it in. He turned his head for an instant to look at his men at work behind him. His iron struck fire on the edge of the hole, an

explosion followed and the tamping bar, three feet seven inches long, one-fourth inch at the small end, about one and one-fourth inches at the large end, weighing about fourteen pounds, was projected upward obliquely in the line of its axis, passing completely through his head and high into the air, falling several rods behind him, and was afterward picked up by one of the men, covered with blood and particles of brain. The man was thrown upon his back by the force of the blow and his extremities moved convulsively a few times, but he spoke in a few minutes. His men carried him to the road a short distance away and he rode home in an ox cart sitting up by being supported. When he arrived at his destination he got out of the cart himself with a little assistance, and an hour afterward walked up stairs with a little aid and laid down upon the bed, where his wound was dressed. He was conscious but very weak from loss of blood.

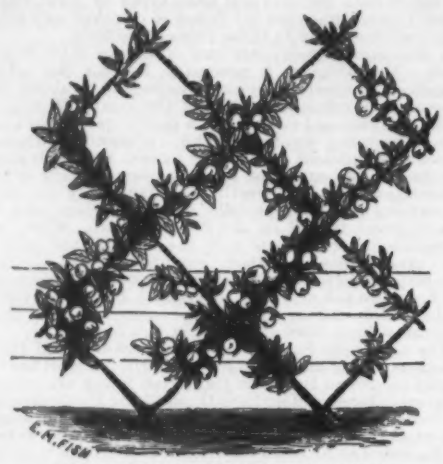
The examination of the wound showed that the iron entered the left side of the face by the pointed end, immediately anterior to the angle of the lower jaw, passed obliquely backward, emerging in the median line, back of the frontal bone, near the coronal suture. The bones were broken in small fragments and forced upward and outward. The hole had much the shape of an inverted funnel, the edges of the scalp everted and the frontal bone badly fractured, leaving an irregular oblong opening in the skull two inches one way and three and one-half the other, through which the pulsations of the brain were distinctly seen and felt.

The wound was dressed and the man showed no apparent signs of serious injury excepting a curious agitation of the legs, which were alternately retracted and extended. Then began a battle, the natural consequences of such an accident against the strong constitution of a healthy man. No one thought it possible that he could recover, but after a few days he began to improve and the fifty-sixth day from the accident the patient was up and walking about the house and piazza. The sixty-fourth day he caught cold and serious consequences were, for a time, feared, but he recovered. Ten days afterward he was taken in a carriage and driven to Lebanon, N. H., a distance of thirty miles or more.

Gage passed the winter months in Lebanon, but returned to Cavendish the following April, carrying his iron with him. He was then in good health and flesh, but in his mind was weak and childish, and the sight of the left eye was entirely lost. He visited South America, passed some time in Valparaiso, then went to San Francisco, where his mother had moved. He died there of epilepsy, May 21, 1861, nearly thirteen years after the accident. The skull and iron are now in the museum of the medical department of Harvard University, and the illustration given herewith shows the track of the iron through the skull.

CORDON FRUITS.

ALTHOUGH this mode of cultivating the pear is considered trifling by some, and does not meet the requirements or convenience of others, it has nevertheless irrefragable advantages in some respects, which are apparently becoming widely appreciated, if we may judge by the increased demand for trees of this form. To those possessing only a limited run of walls or trellises, who are desirous to obtain therefrom as long a succession of fruit as is possible, the cordon is invalu-



DIAMOND FENCE OF APPLES.

able, for it is certainly unequaled as a fruit bearer, besides having other advantages, and the fruit that cordons bear while quite young are of the largest size and best quality. The management is simple, its rooting space very small, and it quickly covers walls, etc. The length of time that trees which have their growths much restricted will produce good crops is a question often asked, and one which I admit I am not qualified by experience to answer, notwithstanding the fact that we have some three hundred and fifty cordon pears upon walls, the oldest of which cover a wall fifteen feet in height, but these have been planted only four years. At the same time having seen the noted trees at Holme Lacy in bearing, during the time Mr. Denning was in charge of them, I think I may safely assert that cordons can be kept in a satisfactory state for as long a time as any other form of tree that is confined to a given space.

Cordons are grown with a single or with two stems or branches, but the former if the stock is the quince

SPIRAL CORDON APPLE.

is usually preferred. Such plants should be set out two feet apart, if the finest fruit is looked for or expected; or they may be put at eighteen inches apart, and trained either erect, obliquely, or horizontally, as suits convenience or taste, although it has been said, for reasons that are apparent, that those fixed perpendicularly are not so fruitful as those which are inclined to one side or the other—but this is not substantiated by my experience. The pear, like other fruits, pays for care in planting, and I planted the cordons here in the following manner: Holes three feet wide, and the same in depth, were dug out at the foot of the walls, the borders being old, furnished years ago with tile drains. Brick rubble to the depth of six inches, and covered with turves, was placed in the bottom of each hole, the remaining space being firmly filled to within six inches of the top with moderately heavy maiden loam, but having no old mortar or lime mixed with it, because these were not at command. Upon this the trees, after cutting off the jagged ends of the roots, were placed in position; the roots spread out, and covered with about four inches of soil, fine particles being worked among them with the hands, and a mulching of stable manure completed the planting. Of course, every one is not favored with maiden soil at hand, but that is not a vital matter, for the pear can be grown well in most soils of a loamy character, be they light or heavy; one matter of importance must not, however, be overlooked—that of securing perfect drainage.

Pruning simply consists of shortening the shoots in July, and again in October, cutting these growths back to two leaves from their base, and removing unfruitful spurs, or those that are superfluous; while in order to preserve a balance between root and top, and thereby assist to keep the trees fruitful, the former, particularly those of free-growing varieties, must be cut in periodically, or as is found necessary. Feeding with liquid manure, or some other surface mulching, should be practiced, especially soils which are light or poor. Respecting aspect, I may mention that the trees in this garden are on south, east, and west aspects, and good fruit is gathered from each. The greatest enemy that we have are the spring frosts, which are intensified by our moist situation.

We have merely a good selection of varieties of pears, and of these the following are the best bearers, and

SINGLE CORDON APPLE.

moderate growers: Beurré d'Anjou, Doyenné du Comice, Durondeau, Easter Beurré, Josephine de Malines, Louise Bonne of Jersey, Marie Benoist, Marie Louise, Olivier de Sèrres, and Winter Nelis, all varieties of good quality. The more or less unfruitful ones, and the most luxuriant growers, are Beurré d'Amanlis, General Todleben, Bergamotte d'Esperen, and Beurré Hardy; the last, however, is studded with fruit buds at the present time. Of these, Doyenné du Comice excels in point of flavor, and I should like to call attention to the good qualities of Beurré d'Anjou and Marie Benoist, which, I think, are not so much cultivated as they deserve to be.—*So says Mr. T. Coomber.*

Writing on the same subject, Mr. H. Markham says:

Pears on Walls.—The leaves having fallen, pruning should be pushed forward. Old trees usually have too many long fruit snags, and these should be sawn off to within half an inch (or less) from the main branches, and smoothed over. Care should be taken not to cut off many of the fruit-buds; and all shoots made in the summer should be cut back to a couple of buds from the base, regulating and fastening the main shoots, and leaving space for the wood to increase in thickness. Young trees should have their leaders shortened back to where the next pair of branches is wanted, leaving one bud to make the leader next season, and this should be annually practiced till the tree has made its last pair of branches, or, if a fan-trained tree, till the space is covered.

In whatever mode it is intended to train young trees, be it horizontal, fan-shape, or herring-bone, the branches must be sufficiently far apart to allow of a clear space of wall being visible between the foliage, thus allowing the direct rays of the sun to reach the fruit. For small-leaved varieties nine inches should be left, and for strong growers or large-leaved varieties twelve should be left. Do not shorten back

DOUBLE CORDON APPLE.

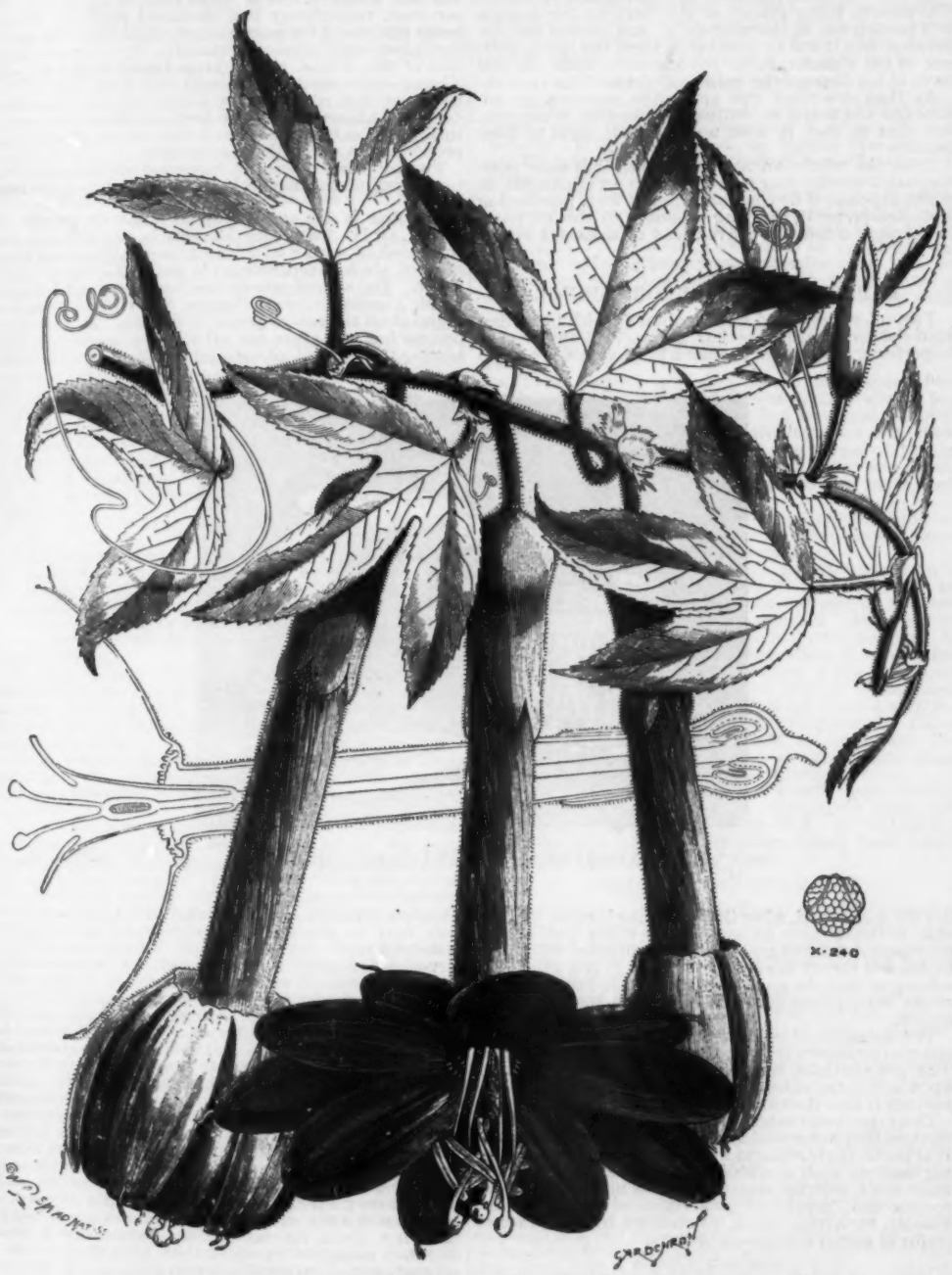
too closely the side shoots, which will form the main branches, but leave these of good length, and they will soon furnish themselves with fine fruit spurs without much stopping. Cordon pears planted at fifteen inches apart soon refill the walls, or they may be planted wider apart, and from two to three branches trained from each at one foot apart. Horizontal cordons look nice objects, and bear well by the sides of paths, if lifted occasionally, and properly treated. They should stand about twenty inches from the ground. Bushes should be planted where there is space for them in the kitchen garden, and they are preferable to pyramids, the fruits being more exposed, being finer, and higher developed. When pruning pyramids, cut to an eye on the opposite side to which it was cut the previous year, so as to provide symmetry of form; and put to each tree a stake sufficiently long to fasten the growing leader to. Bushes should be made with an open center, and the several branches trained outward by means of stakes, and secured for a few years till the position becomes fixed. Newly-planted pears should not be pruned till February, and those spring-planted not before a year has elapsed.—*The Gardeners' Chronicle.*

CORDON PLUM TREE.

TACSONIA (HYBRIDA) SMYTHIANA.

WE avail ourselves of the opportunity of figuring a very handsome Tacsonia, raised by Mr. Smythe, in the gardens of Basing Park, near Alton, apparently between T. mollissima and some other species. The leaves are dark green and glabrous above, softly hairy beneath, deeply divided into three lanceolate serrated lobes. The flowers measure about 5 inches in length, and are provided with a tubular cylindric calyx, slit on one side, and downy within. The flower tube is glabrescent, or slightly downy, the calyx lobes oblong-aristate, the petals rather shorter, oblong-obtuse, of a peculiar and most distinct color which some have called rosy salmon, and others orange scarlet—in any case, it is very brilliant.

The corona consists of a double row of small, blunt, purple tubercles. The elliptic-oblong ovary is downy. These characteristics are very like those of T. mollissima, but the color is entirely different. Mr. Smythe, who has sent us flowers on more than one occasion, tells us the plant has been flowering freely out of doors on a south wall throughout the summer. It was growing in a ten-inch pot, which was removed at the end of October into the greenhouse, where it continues to flower: indeed, it is, in Mr. Smythe's opinion, one of the very best greenhouse and conservatory climbers, flowering for nine or ten months of the year. The plant has been previously figured in the *Gardening World*, but we have, unfortunately, mislaid the reference, and are quoting at second-hand. It is therein stated that the plant was raised between T. manicata and T. (hybrida) exoniensis; but this seems very unlikely. The peculiar slit calyx points to mollissima or tomentosa as one of the parents.—*The Gardeners' Chronicle.*



TACSONIA HYBRIDA SMYTHIANA. (FLOWERS, ORANGE-SCARLET.)

RECENT DISCOVERIES IN ROME.

ROME for her sins is now the capital of united Italy. During the last twenty years there has not been a day when this city has not resembled Paris in the sixties, under the hand of Baron Haussman. Rome is in a state of transition, and is being changed as rapidly as possible from one of the most beautiful cities into a replica of a Paris suburb. Though it is desirable to have fine boulevards and wide, straight streets in any city, it is greatly to be deplored that this necessity should have arisen in Rome, which is a heritage for all time. As far as the officers of the government are concerned, they are less blamable than the real estate speculators, for when it becomes necessary to open new streets the government has a constant attendance of men well versed in archæology, and everything exhumed is carefully preserved. In case any considerable ruin is discovered, and its removal becomes necessary, photographs and accurate plans are made, but in the case of real estate speculators and the scions of noble families their greed is so great that the excavations are farmed out to unscrupulous antiquity mongers, who seize and sell everything they find. Though much of the romance and the beauty of Rome, the Rome of Shelley, of Byron, and of Hawthorne, has been destroyed by these modern improvements, still it is not without its good results, for the new streets have opened up priceless treasures. But the old buildings, with their stately gardens and the avenues of ilexes, are gone forever.

Several important works on Rome have appeared in the last four years, chief among which are "The Remains of Ancient Rome," by J. Henry Middleton, the author of the scholarly essay on Rome in the "Britannica," and this work is, without doubt, the greatest single book on Rome for the archæologist, as the drawings and plans are all made to scale, and great attention is paid to the construction. The plan of the Forum is a model of plan making. The works of Com. Lanciani, "Ancient Rome in the Light of Recent Excavations" and "Pagan and Christian Rome," give rare pictures of Rome, its government, police, water supply, and commerce. Murray's "Guide to Rome" is a very valuable work, on account of its fine maps and plans. These four works, taken together, give an almost complete picture of Rome in the time of her grandeur.

Let us now examine some of the recent excavations. The first ruin to which the traveler would naturally bend his steps is to the Forum, or *Forum Romanum*. Here the excavations are open daily, and, let it be said to the credit of the Italian people, are open without charge. Some of the most important discoveries in the entire city have recently taken place here. Lanciani says: "If in 1870 any one had spoken to us of the probability of an imminent and complete restoration of the Forum from end to end, we should have denied the possibility of such an enterprise being accomplished in a single generation. But now the golden dream has become a reality. To-day, for the first time since the fall of the empire, we are able to walk over the pavement of the *Sacra via*, admiring on either side of the wonderful road the most glorious monuments of the republic and the empire."

The space between the column of Phocas and the arch of Septimus Severus was occupied by a roadway, which was used to avoid the long detour around the Capitol. The removal of this road, in 1888, brought to light some remarkable ruins, chief among which was the *Rostra*, 80 feet long and 11 feet high. A number of holes, 20 in the upper tier and 19 in the lower, served to hold the beaks of the ships which were captured by Julius Cæsar at the battle of Actium, which give the platform its name. The spot is fraught with the greatest interest, for here Cicero delivered the grand oration against Antony. The hands and head of Cicero were exhibited here, and the marble covering was stained with the blood of Julius Cæsar. Great care and accuracy are displayed in the way in which the clamps, pins, and dowels of iron and bronze were let into the tufa wall and the marble facing. The front of the *Rostra* was provided with a marble balustrade, with a break in the middle to allow the entire form of the orator to be seen.

The *Graecostasis*, or platform for ambassadors, was situated behind the *Rostra*, and this construction was used as one of the points in making observations for determining the hour of noon. On the extreme right of this is a circular structure, consisting of three superimposed cylinders, the lower being 17 feet in diameter. This construction was called the *Umbilicus Romae*, and denoted the central point of Rome.

At the other end of the *Graecostasis* is situated the *Millarium Aurem*, a gilt-bronze column, proclaiming the distances from the thirty-seven gates of the city to all the principal towns in the provinces. This spot is identified with that where Otho was met by the band of soldiers who proclaimed him emperor. This is a truly historic group, and it is, perhaps, wise that this spot should have remained buried until it could be unearthed in the presence of learned archæologists, who could examine the remains *in situ*.

The *Tabulgrium*, or great public office of Rome, has been carefully examined and repaired. It is now a government museum. This remarkable building, which is situated under the Capitol, gives an almost complete view of the construction employed in using three kinds of stone brought into use at different periods.

The house of the Vestal Virgins, or the *Atrium Vestae*, was discovered in 1883-84, and has proved to be of greater general interest even than the *Rostra* group The building is situated under the shadow of the palace of Caligula. The Vestals were priestesses, six in number, whose duty it was to watch continually the sacred fire in the adjacent Temple of Vesta, and also to guard the Palladium saved by Æneas from Troy. The Vestals were selected from patrician families at the age of six to ten, and the period of the vestalhood was thirty years, when they were permitted to return to the world and marry—a privilege of which they seldom availed themselves. Their whole environment was as pleasant and luxurious as a plentiful supply of money could make it, for the Vestals received large fortunes and the order was enormously wealthy. The seats of honor were reserved for them at all public games and rejoicings. The Vestals were amenable to no laws, and when they went driving in chariots every one gave place to them. Any deviation from virtue, however, was punished by burying the unhappy woman alive. The order may be called a secret society, for they undoubtedly had secrets to guard, and when the *Atrium Vestae* was discovered hopes were expressed that some trace of the shrine would be found; but the wish was vain, as the foundation of the shrine only was discovered. It is now believed that the shrine was destroyed by the Vestals themselves before their suppression in A.D. 394. What a thrilling picture could be painted of the last moments of the order—the burning relics and the weeping women about to be thrust out upon the world!

The house of the Vestals was 345 feet long by 171 wide, and there are considerable remains, including a bath, a staircase, a mill, and the method of heating the house is clearly shown. Some of the floors were damp; so they were raised above the level of the ground by means of amphoræ or earthen vessels cut in half. This house has contributed largely to our knowledge of the life of the refined Romans, which differed in some respects from that obtained from Pompeii, which was an essentially Greek city.

The *Regia*, or public office of the *Pontifex Maximus*, has been recently identified near the house of the Vestals. Here the most precious documents were kept, as well as the sacred spear of Mars. The spot possesses great historic interest, as it is supposed to be the very spot on which the funereal pyre of Julius Cæsar was built. It is probable that the antique marble plan, fragments of which are now in the palace of the Conservators, formed part of the wall of the *Regia*.

The Colosseum is to many even more interesting than the Forum. The new excavations have brought to light many interesting facts. The removal of the flora of the Colosseum, in 1871, was carried out in the belief that the life of the structure would thereby be prolonged, but it was injured more in the removal of the luxuriant verdure than it would have been by the flora for centuries. This noblest of ruins seems always destined to suffer more from the hand of man than from that of nature. The subterranean corridors and passages are now exposed in an admirable manner for study. Under the arched podium or raised platform on which the emperor, senators, and Vestals sat are a number of arched cells made in the thickness of the wall. These were undoubtedly intended for wild beasts. This belief is confirmed by the discovery of a channel of running water for them to drink and behind each cage was a trap for the descent of the keeper. In the center a semi-carbonized platform of wood has been discovered. This is supposed to have been part of the tramway used for conveying cages of wild beasts and scenery into the arena. The cages were then lifted up first by means of inclined planes, and these were in later times succeeded by the use of the windlass, the bronze sockets and the stone abraded by the ropes having been found.

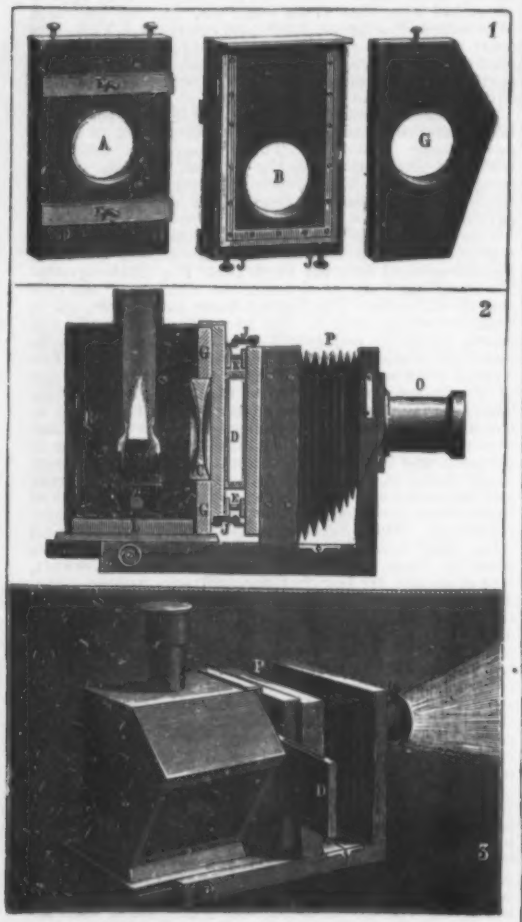
Ten feet below the modern level of the amphitheater were found massive travertine corbels in pairs, with a channel in the brickwork between each. These corbels were evidently intended to sustain the masts which

supported the huge awnings used to protect the people from sun and rain.

A long passage, or *crypto-portious*, has been cleared out to a distance of 200 feet or more, and interesting *graffita*, or caricatures and jokes, have been found scratched on the wall. It is thought by some archæologists that the wild beasts were introduced into the arena from the Caelian hill by this passageway. Much delay was caused in excavating the arena because of tapping an old drain, and the level of the water could not be reduced even by a steam pump until a connection was made with another antique drain at a lower level. Traces have also been found of a continuous wooden gallery at the top for the sailors who attended to the furling of the huge awning which protected the spectators. There is now no doubt that the arrangement of seats was nearly perfect, and that a crowd of sixty thousand persons was handled without confusion.

A SIMPLE PROJECTION AND ENLARGING APPARATUS.

THE system that we are about to describe, and which will permit all lovers of photography to manufacture for themselves a projection and enlarging apparatus, consists of the following parts: (1) A well-constructed 6×8 inch camera permitting of a certain decentration upward. This camera is provided with a piece of wood having the dimensions and thickness of one of its negative frames, and which is put in place of the latter. This should be very well adjusted (Fig. 1, A). This piece of wood should be afterward provided with a circular aperture of a diameter corresponding to that



PROJECTION AND ENLARGING APPARATUS.

Fig. 1.—A, false negative frame; B, cover of the lantern; G, condenser frame. Fig. 2.—Side view of the apparatus: A, false negative frame; B, lantern cover; C, condenser; D, sliding frame for two negatives to be projected; E, iron rods holding A and B opposite each other; G, piece to which the condenser ring is fixed; J, elastic junction of A and B by rubber bands; L, modified kerosene lamp; R, reflector. Fig. 3.—Apparatus in operation.

of the condenser that it is desired to employ. The center of this aperture must be at the same height as that of the aperture in front of the camera when the front is put out of center upwardly.

Upon the external surface of the wood, that is to say, the surface that will be outside when it is placed upon the camera, are fixed two thin strips of wood designed to serve as guides to the positive frame. As the latter needs to be quite carefully constructed, we recommend the purchase of one of the positive frames that are to be found in commerce at a very low price. (2) A laboratory lantern, with inclined glasses of medium dimensions and well constructed, so that the light shall not pass through all the sides. Upon one of its sides this lantern is provided with a rectangular aperture, closed by a piece of tin sliding in a groove. This cover is removed and another piece of wood is taken, having about the same dimensions as the one that replaces the negative frame, and to three of the sides of the rectangle is fixed a band of zinc or tin, bent so that the board may be put in the place of the original cover (Fig. 1, B). Afterward, the lantern is placed in the back of the camera, the side on which is situated the aperture closed by the piece of wood against the false negative frame, and the place is marked where it is necessary to form the corresponding circular aperture, as well as the place where it is necessary to fix the two other strips of wood opposite those of the frame. This done, a piece of wood is taken and given the dimensions of this internal side of the lantern. This is fixed by means of a nail that may be removed at will. The place of the circular aperture is marked like that of the other pieces, and into this aperture is inserted the ring that accompanies the condenser. The ring is afterward fixed to the wood by means of a few screws or nails (Fig. 1, G).

The burner of the kerosene lamp is replaced by a larger one, or, if the construction of the lamp does not admit of this, a round burner of fourteen lines is soldered to a sardine box. This will then give a sufficient illumination. Behind the flame is placed a small concave mirror. The reflector of a carriage lamp will answer perfectly. Such mirrors are of silver-plated copper, and cost but a trifle. It is necessary to take care that the center of the reflector coincides with the center of the flame, condenser and objective.

If it is desired to suppress the red light given by the lantern, it suffices to add a piece of cardboard, tin or zinc, in lieu of a third glass.

The lantern may receive any other mode of lighting —gas, electricity, etc.

These various preparations made, it is necessary to unite the two boards placed on the exterior of the apparatus by a few rubber bands attached to the two pieces by tenter hooks, in order to bring them together, while at the same time leaving all the elasticity necessary to effect the changing of the frames.

In this way is constructed the enlarging apparatus. The lantern being placed at the back of the camera will participate in the motions of this part of the apparatus, and it will be possible to focus the image with one of the objectives that one possesses, since one will have at his disposal the entire extension of the camera.

As thus described, the apparatus possesses an advantage not found in ordinary projection apparatus, and that is, that it does not allow the light to filter outside.

Upon the whole, an amateur possessing some little manual dexterity may construct such an apparatus at slight expense, if he contents himself with purchasing a condenser, or if, carrying economy to the extreme, he employs a convexo-convex lens of sufficient size.—*La Nature.*

EXPERIMENT ON FLUORESCENCE.

THE colors extracted from coal tar furnish us with a material for experiments that are as brilliant as easy to perform. It suffices to take a large tumbler and fill

EXPERIMENT ON FLUORESCENCE.

it with water, and, after the latter has become immovable, to throw upon its surface a few fine particles of fluoresceine. Small grains of this substance will begin to descend slowly toward the bottom of the glass, dissolving as they do so, and leaving behind them yellow trains with green fluorescence of the most brilliant aspect.

The quantity of coloring matter to be employed in order to produce the phenomenon is exceedingly small. The few particles that remain adherent to the paper upon which the substance has been placed previous to putting it into the tumbler are amply sufficient.

This experiment succeeds with all the artificialcoloring matters that water readily dissolves, but not too quickly It is particularly remarkable with the fluorescent coloring matters, such as eosine, erythrosine, etc. The nonfluorescent coloring matters, such as malachite green, coceine and French red, give trains of a single color. Finally, by mixing them, we obtain a true bouquet of trains of varied colors.—*Le Nature.*

THE ADULTERATION OF LINSEED OIL WITH RESIN OILS.

By F. CORBIL.

RESIN oils have long been used for the adulteration of the various oils employed industrially, and especially of linseed oil.

The detection of this form of adulterant does not present any difficulty. Resin oils have a very high density (from 960 to 1,000). Moreover, they all rotate the plane of polarization of light strongly to the right, and this is their most distinctive property. Oil of sesame alone of the other oils rotates the plane of polarization in this direction, but the rotation of this (from 3·1-7·7 saccharimetric degrees) is insignificant in comparison with that produced by the resin oils, which may amount to 200 degrees (according to M. Buland, of Marseilles, who has furnished this information).

These oils, however, possess various other characteristic properties.

They become red and then brown when treated with stannic chloride, and like the mineral oils they cannot be saponified by caustic alkalies.

The special color, odor and taste of the resin oils may also serve as a means of detecting them, since the addition of only $\frac{1}{10}$ per cent. of the adulterant is sufficient to completely alter the smell and taste of linseed oil. To these properties may be added that of becoming brown and then black when a current of chlorine is passed through them. This property also belongs to the animal oils, and has not, as far as I am aware, been previously observed with the resin oils. The production of this black color has in fact been considered as characteristic of the animal oils, but, notwithstanding this, I have met with eight samples of resin oils which were all turned brown and then black by chlorine. M. Buland informs me that two samples of these oils in his possession show the some reaction.

To show how this reaction may be employed to detect resin oil in linseed oil, I quote one of my experiments.

A current of chlorine was passed for three minutes into linseed oil, and then for similar periods into the same oil to which 5, 10 and 20 per cent. of resin oil had been added, and finally into the resin oil employed.

The pure linseed oil became		slightly discolored.
5 per cent. of resin oil	"	as above.
10 per cent. of "	"	slightly brown.
20 per cent. of "	"	slightly brown.

The resin oil itself became of a reddish brown color.

These oils examined after standing for five minutes had not changed, unless those containing 10 and 20 per cent. respectively had darkened slightly. Three hours afterward the pure linseed oil had not changed; the 5 per cent. mixture was of a light brown tint, that of 20 per cent. was a little darker, and the resin oil was quite black. Although it is easy enough to recognize the resin oils by means of the properties described above, even when they are present in a mixture, yet it is by no means so easy to determine the proportion in which they are present.

Two processes have been suggested and are employed to determine the amount of resin oils in vegetable oils.

The first is due to M. Remont (Jour. de Pharm. et de Ch. (5) II., 1880), and consists in saponifying the suspected oil with a solution of caustic potash in presence of alcohol, separating the residual oil and weighing it. The second process has been brought forward by M. Aignan (Comptes Rendus, 110, 1273, 1890), and is founded on the rotary power of the oils. M. Remont's process has not given me satisfactory results in estimating the amount of resin oil in oil of linseed. The complete separation of the unsaponified product is not very easy to effect, at all events with the mixtures tested by me. Moreover, as M. Remont himself observes in his paper, "Resin oils, which in addition to hydrocarbons contain substances related to the phenols, are not completely unattacked by alkalies." In such a case, supposing even that a perfect separation were effected, a certain proportion of the resin oil would be combined with the alkali and would not be estimated, thus causing an error which may be of importance. The method proposed by M. Aignan is based on the fact that a mixture of oils of resin and of linseed rotates the plane of polarization of light to the right in proportion to the amount of resin oil present. This process would be excellent if all resin oils had the same rotary power; this is, however, not the case, some oils only producing a rotation of a few degrees, while with others it may amount to 200 saccharimetric degrees.

From whatever cause, the two processes referred to have not given me satisfactory results, and I have therefore employed for the analysis of these mixtures a volumetric method similar to that proposed by Koettstofer for the direct titration of butter by means of an alcoholic solution of potash.

The method which I propose is certainly not rigorously exact, but it appears to me both more convenient and more practical than the two processes now in use, and I therefore do not hesitate to publish it.

Two grammes of the oil, which has been previously freed from air by exposure to a temperature of 105° for 4-5 hours, are weighed out exactly into a Bohemian glass flask; 40 c. c. of a semi-normal alcoholic solution of potash (28·05 grms. per liter) are added and the whole heated on the water bath for two hours. When the linseed oil is pure, the saponification is complete at the end of an hour and a half, the liquid being free from oily drops and not being rendered turbid by the addition of water. When resin oil is present to the amount of 10-15 per cent., this is never the case, oily drops are always left and can be perceived on shaking the flask, and water always produces turbidity. After two hours the mixture is removed from the water bath, allowed to cool, and two drops of an alcoholic solution of phenol phthalein added, the excess of alkali being then titrated by a semi-normal solution of hydrochloric acid (18·18 grms. per liter). The difference gives the number of c. c. of semi-normal acid required to saturate the alkali combined with the fatty acids of the oil. This number multiplied by 0·02805 and divided by 2

gives the amount of potash (hydrate) saturated by 1 grm. of oil.

I have determined the amount of potash neutralized by 1 grm. of linseed oil, and by the same amount of resin oil, the experiments being made with seven samples of genuine linseed oil (two of which were prepared by myself) and eight samples of resin oil from different sources. The following are the results obtained:

Linseed Oil.	Potash per grm. in mgms.		Resin Oil.	Potash per grm. in mgms.
1	2 2	White oil.....	1	30
2	201		2	38
3	221		3	36
4	213		4	27
5	210		5	41
6	211		6	20
7	218	Green oil.....	7	6
			8	11

Thus 1 grm. of linseed oil requires from 201–221 mgms. of potash, while the white resin oils, which are most generally used for adulteration, only require 20–41 mgms. The proportion of resin oil in any sample is therefore found by the use of the following formula:

$$\frac{100\ (211-n)}{211-31}$$

in which 211 is the mean obtained for linseed oil, 31 the mean for resin oil, and n the amount of potash required by the sample under examination.

The color of the green oils enables their presence in linseed oil to be readily detected, when about 10–20 per cent. are present, and the numbers obtained for green oils can then be substituted in the above formula.—*Jour. de Pharm. et de Chem.; Chem. Tr. Jour.*

SIMPLE CHEMICAL ANALYSIS.*

THE subject on which I am going to speak this evening is one, I think, which should be of interest to all working photographers. The knowledge of chemical analysis to a photographer is a powerful weapon to fight the many difficulties in which the path of photography runs. And, again, this knowledge will give him the means to enable him to test his tools by which his work is produced. (In reference to tools here, I mean such solutions as may be used to produce certain results.) It is, I think, needless for me to dwell upon the many advantages which will arise to those who have the power of being able to detect any of the substances which they may use in their work. It will therefore be my endeavor to show you that this subject is not one which is beset with any great difficulties, but is one which is quite capable of being manipulated by any one who possesses an average amount of intelligence.

HINTS TO TYROS.

I will now proceed with a few short notes, which will be found of use to those who have not done any of this work before:

(1) When adding a reagent to a solution and a PP† is formed, be sure to add sufficient of the reagent to insure that the whole of that particular substance is thrown down.

(2) Do not hurry therefore if a certain effect is not produced immediately. Do not imagine that the particular substance you are testing for is not there. Some reactions are at once apparent, and others take some little time.

(3) In commencing analysis, always analyze some substance the composition of which you are aware, and note the effect produced by this of certain defined reagents.

(4) Always test an unknown substance for the base or metal first, and then for the acid which has combined with it. For example, in sodium chloride, the sodium is the base, and the chlorine is the acid which has combined with it. When you have detected the base of an unknown substance, this will give you some idea as to what acid it belongs.

(5) Always confirm the result given by one reagent by testing with another reagent for the same substance. For example, in adding a solution of BaCl, to an unknown solution, you may get a PP soluble in HCl, and yet it may not be a sulphite; therefore you must confirm the fact of its being a sulphite by the granulated zinc test.

(6) To test with borax beads, place a little borax on the loop of your platinum wire, and hold same in the Bunsen flame; it will boil up, and then fuse to clear glass. Now place a little of the substance to be tested on the bead; heat same, and allow to cool; then notice the color of the bead. If the color of the bead is too dark to make out the exact color, add more borax and heat again; this will lighten the color of the bead. Chromium is about the only element in everyday use in photography which gives a characteristic color to the borax bead.

(7) The following is the method of using the platinum wire for flame tests: Hold the wire in the Bunsen flame until it ceases to give the intense yellow color, then place a little of the substance to be tested on the wire, and hold it at the lower edge of the flame. Sodium gives a very strong yellow color to the flame; potassium gives a pale lavender color.

To make a platinum test wire take about two inches of platinum wire and double the same in half, then twist together, so as to leave a small loop at one end. Mount this in a small piece of glass tube, so as to form a handle. Taking a test tube of about half an inch diameter, you fit a cork to it, and make a hole in the cork large enough to take the glass tube handle. Push the handle through the hole in the cork, partly fill test tube with weak hydrochloric acid, and, by putting the cork in the test tube, you have your platinum wire always clean and ready for use.

APPARATUS.

The following are the apparatus required for practice of analytical work: test tube stand, test tube brush, twelve test tubes, 5 × ¾, six test tubes on feet, one test tube holder, spirit lamp or Bunsen burner, wash bottle, two small evaporating dishes, two small glass funnels, one packet of filter paper, three inches of platinum wire, two watch glasses, one nest of small beakers, retort stand, one piece of wire gauze, one piece of charcoal, and a blow pipe. This may seem rather a long list; but, as the whole of the apparatus can be purchased for something like ten shillings, the list is rather more lengthy than expensive.

REAGENTS.

We will now pass on to the various reagents that we shall require: Acetic acid, 1 oz. to 1 oz. of water; ammonia, 880 s. g. diluted with about twice its bulk of water; hydrochloric acid, strong; hydrochloric acid, dilute ½ oz. of acid with 1½ oz. of water; sulphuric acid, strong; sulphuric acid, dilute ¼ oz., is made up to 2 oz. with water; nitric acid, strong; nitric acid dilute, ½ oz. to 1½ oz. of water; ferric chloride, 20 gr. to 2 oz. of water; lead acetate, 20 gr. to 2 oz. of water, and a little acetic acid; barium chloride, 60 gr. to 2 oz. of water; silver nitrate, 20 gr. to 2 oz. of water; potassium ferricyanide, 20 gr. to 2 oz. of water (this solution should be made up as required, as it does not keep); potassium ferrocyanide, 20 gr. to 2 oz. of water; potassium iodide, 20 gr. to 2 oz. of water; caustic soda, 40 gr. to 2 oz. of water; ½ oz. of platinum chloride; lime water; a piece of lime about the size of a walnut should be well shaken up in about 10 oz. of water, allow to settle, and decant the clear liquid off. With the following dry reagents in wide-mouthed bottles: Ferrous sulphate, sodium carbonate, black oxide of manganese, granulated zinc, together with some red and blue litmus papers, starch and lead papers, and a little borax.

THE DETECTION OF BASES.

1. *Silver and Lead Salts.*—All give a white PP when treated with HCl. Add ammonia, if silver PP will dissolve. If the PP is lead, on boiling the solution the PP will be dissolved. Sodium hydrate also dissolves the lead PP.

2. *Mercuric Salts.*—(*a*) Sodium hydrate, when added in excess, gives a yellow PP, soluble in HCl. (*b*) Pot. iodide gives a yellow PP, which changes to a bright red. This PP is soluble in excess of pot. iodide or mercuric salts. (These mercuric salts must not be confounded with the mercurous salt, which gives a white PP with HCl, which is blackened on the addition of ammonia.)

3. From *Ferric Salts.*—(*a*) Pot. *ferri*cyanide gives a dark blue PP, (*b*) sodium hydrate and ammonia a brown PP.

4. From *Ferrous Salts.*—(*a*) Ammonia hydrate gives a light color green PP, which turns a dirty green and afterward a reddish brown. (*b*) Pot. *ferro*cyanide gives a blue-green PP, which afterward turns to a dark blue. (*c*) Boil a ferrous solution with a few drops of strong HNO_3. The liquid becomes black, effervesces, and, turning yellow, becomes changed into the ferric condition.

5. *Sodium Salts* give no PP with platinum chloride, but give the Bunsen flame a very intense yellow color, which is quite characteristic of sodium.

6. *Potassium Salts.*—(*a*) Place a watch glass on a piece of white paper, and place a little of the liquid to be tested on it; then add a few drops of platinic chloride and a few drops of alcohol. After a few minutes a yellow PP will fall if the solution is not too dilute. If no PP falls, allow it to rest for half an hour, giving the solution a stir now and then. (*b*) Potassium salts also impart a lavender color to the Bunsen flame. This color is not very intense, as the sodium in the air always gives the flame a little yellow color, which tends to overpower the light color of potassium. A piece of cobalt color glass is sometimes used to cut off the sodium flame.

7. *Chromium Salts.*—(*a*) Treated with lead acetate give a yellow PP. (*b*) With silver nitrate a deep red PP is given which is soluble in HCl. (*c*) Chromium salts also give an emerald green borax bead when heated in the outer or inner flame.

THE DETECTION OF ACIDS.

8. *Acetic and Acetates.*—(*a*) Ferric chloride in neutral solutions produces a deep red color, which, on the addition of HCl, turns yellow. (*b*) On boiling the red solution the iron is PP as a basic acetate, and the liquid becomes colorless.

9. *Citric and Citrates.*—(*a*) A fairly strong solution, if mixed with H_2SO_4 and heated, will blacken, and, if evaporated down, will leave a black sirupy residue. (*b*) Will also PP lead acetate soluble in HNO_3.

10. *Oxalic and Oxalate.*—(*a*) Barium chloride gives a white PP soluble in HCl and HNO_3. (*b*) Silver nitrate gives a white PP soluble in HNO_3 and ammonia.

11. *Hydrochloric and Chlorides.*—(*a*) When treated with silver nitrate it gives a PP which is soluble in ammonia. The PP turns violet if exposed to light. The PP is insoluble in HNO_3. (*b*) See test (1) for lead.

12. *Nitric and Nitrates.*—Take a weak solution of a nitrate, and add equal bulk of a solution of ferrous sulphate in a test tube. Hold the tube at an angle of about forty-five degrees, and carefully pour down the side of the tube a few drops of strong H_2SO_4. After a few seconds a brown ring is formed at the junction of the two liquids. After it has begun to form, a little gentle shaking assists the formation of same. This is a very delicate test.

13. *Sulphureous Acid and Sulphites.*—(*a*) Barium chloride produces a white PP soluble in HCl. (*b*) Put into a test tube some granulated zinc, add HCl, let it effervesce, then pour some of the liquid to be tested into the tube. The gas H_2S will be given off, which may be detected by the smell and by its power of turning lead paper black.

14. *Sulphuric Acids and Sulphates.*—(*a*) Barium chloride gives a white PP insoluble in HCl. (*b*) Powder a little of a suspected sulphate and mix with equal parts of powdered charcoal, stir into a paste with a little water, and place the mixture on a piece of charcoal. Heat in the reducing flame for a few moments and take a little of the residue, powder it, and place on a bright silver coin. Add a drop of water, and, if the substance tested was a sulphate, a brown black stain on the coin will be the result.

15. *Carbonic Acid and Carbonates* (CO_3).—Carbonates when treated with HCl evolve CO_2 (carbon dioxide). If this gas is led into a vessel containing clear lime water, and allowed to bubble through, the lime water will become milky, and a PP of calcium carbonate will be formed.

16. *Bicarbonates* (HCO_3).—The bicarbonates or hydric carbonates give off carbon dioxide on boiling solutions of these acids. The solids dissolve in boiling water with effervescence. The carbon dioxide may be detected as in the last test.

17. *Thiosulphates.*—(*a*) On adding HCl to a solution and gently warming, a PP of sulphur will fall, with a smell of sulphur dioxide. (*b*) Silver nitrate gives a white PP soluble in HNO_3. This PP is blackened on heating.

18. *Bromides.*—(*a*) On heating with H_2SO_4 and black oxide of manganese evolve bromine, which may be detected by its red color and its power of turning starch paper yellow. (*b*) Will also PP silver nitrate, insoluble in weak HNO_3 and soluble in ammonia.

19. *Iodides.*—(*a*) Heat as with last test a mixture of H_2SO_4 and manganese, and hold a piece of wet starch paper in the tube. The paper will be colored purple if iodine is there. (*b*) Iodine will also PP silver nitrate almost insoluble in ammonia.

20. *Ammonium.*—(*a*) All ammonia salts can be volatilized. For example, place a little of some ammonia compound in the end of a long test tube, heat it, and a sublimate of ammonia will be formed at the other end of the tube. (*b*) To test a solution for ammonia, add caustic soda, heat gently, and ammonia is given off, which may also be detected by its action of turning wet red litmus blue. White fumes will also be given off if an open bottle of HCl is brought near.

21. *Ferrocyanides.*—(*a*) Silver nitrate gives a white PP insoluble in HNO_3 and ammonia. (*b*) Ferrous sulphate gives a PP of blue green.

22. *Ferricyanides.*—(*a*) Silver nitrate gives a PP of orange red, soluble in ammonia. (*b*) Ferrous sulphate gives a deep blue PP, soluble in sodium hydrate.

23. *Cyanides.*—(*a*) Silver nitrate gives a white PP, insoluble in HNO_3, soluble in ammonia. (*b*) Silver cyanide when heated to red heat is reduced to metallic silver.

I will now conclude with a brief review of the manner to go to work to detect any of the ordinary chemicals that may be found on a photographer's work room shelf.

If the substance is a solid which you wish to test, dissolve about twenty grains of it in a test tube with about one ounce of distilled water. This solution is called the original solution. We will now proceed to test for the base. Before, however, proceeding to test the solution of the chemical, place a little of crystal on the platinum wire and heat in the Bunsen flame. Note the color it imparts to the flame. Now we will proceed to test the solution. Take about one drachm of the original solution, pour into a test tube, and add a little dilute HCl. If you get a PP, it may be lead or silver (1). If you do not get any PP, add to another portion of the original solution some ammonia sulphite. A PP in this case indicates iron (3 and 4). If no PP forms, take a few drops of the original solution, and use test for potassium (6). Then test for chromium and mercury (2 and 7). After having found the base, you must then test for the acid which is united with it. The knowledge of the base will give you some idea as to what acid you may expect. It is as well to always use fresh portions of original solution for every separate test you make.

In conclusion, I would ask every photographer who likes a little experimental work to give chemical analysis a trial, and I am sure that he will not only find the same very valuable in his ordinary photographic work, but also a source of pleasure independent of photography. I think an apology is due to you for the rather curious way this paper and tests are arranged. I will ask you to excuse me on the ground that my aim in the paper has been to make it as simple as possible, and to avoid introducing those chemicals which are very seldom, if ever, used by the ordinary run of photographers. To those who wish to go into this subject deeper and in a thorough chemical manner, I can recommend the following works: *Analysis of a Simple Salt* (price 2*s.*), published by Clive & Co.; *Practical Chemistry*, by Tilden (price 1*s.* 6*d.*), published by Longmans, Green & Co.; *Qualitative Chemical Analysis*, by Thorpe and Muir (price 3*s.* 6*d.*), published by Longmans; and a far more elaborate and difficult work, *Valentine's Analytical Chemistry* (price 7*s.* 6*d.*), published by Churchill. The following abbreviations have been made use of in the paper:

PP for	Precipitate.
HNO_3 for	Nitric acid.
HCl for	Hydrochloric Acid.
H_2SO_4 for	Sulphuric acid.

ERNEST BENEST.

* Holborn Camera Club.—*Br. Jour.*

† For explanation of abbreviations see end of paper.

THE MINES OF SOMBRERETE, MEXICO.

THE first mines discovered in this locality were those of La Canada. It is probable that it was some time after this that the Pabellon, Veta Negra and San Lucas veins were discovered. They are situated on a hill known as the Cerro de la Cruz. The Pabellon vein is the most important in Sombrerete, having a width of 64 ft., according to the statement of Mr. Francisco de P. Zarate, an engineer who visited this department for the government of the state at the time when the property was owned by Mr. Nestor Ontiveros. The Pabellon ores differ considerably, but the sulphide ore runs from 500 oz. to 4,200 oz. to the ton.

The famous Veta Negra has a width of thirty-two inches, although sometimes it narrows down to eight inches. It is precisely where the vein thus pinches that the ore is of the highest grade. During the eighteenth century this mine produced immense quantities of silver. At the time when it was being exploited, work on the Pabellon and San Lucas veins were commencing. The owner of the latter, Senor Fagoaga, became discouraged with the results and was about to abandon them, when a strike of a large body of ruby silver was made. During that period the production of silver was considerable, amounting, it is said, to $11,000,000 in eleven months. Unfortunately there is no really authentic data on the subject, but it is stated that the daily production of silver was $20,000, free of cost.

In the department of La Canada are found the Rosario, San Francisco, El Refugio, San Amaro, Las Marias, San Jose de la Cumbre, La Joya and Cruz de Moros mines, although some of these are really outside of La Canada. Of all of these the San Francisco mine,

up to date, has produced the most at various times, although the others are important for the high grade of their ore, notably the Las Marias.

The San Francisco vein seems to be a branch of the great Pabellon vein, which divides into two. A confirmation of this may be found in the difference in width, which, in the mine of which we speak, is from 10 to 13 ft., although sometimes it is only 6½ ft. The ore contains lead, silver, antimony, iron and arsenic, and other metals in smaller quantities. At present the mine is in very good condition, and the Santa Rosa mill is unable to concentrate all the ore produced. The concentrates are shipped to San Luis Potosi for reduction. The Sombrerete Mining Company, which owns this and the Pabellon properties, has two large steam engines of 500 H. P., for hoisting ore and bailing—one on the San Pedro and the other in the San Francisco. The gangue of the vein is a decomposed chloritic slate. The concentrates run from 73 oz. to 128 oz. to the ton, although it sometimes goes higher. The lowest workings are at a depth of 960 ft.

The company is now working only the San Francisco mine, but it is said that it will shortly commence operations on the Pabellon and Veta Negra system. In the San Pedro shaft, as has been stated, there is already lifting machinery of sufficient power. The ore in the latter vein system is richer than in the San Francisco, and this should urge the company to work earnestly.

The history of the American ownership of these mines may prove interesting. They were acquired about 1880 by George Tew, acting for an American syndicate. The first cost was merely nominal, indeed we believe that the property had been abandoned, and that simple relocation was all that was necessary to secure these properties. Boston and New York capital was secured, and operations were commenced on a large scale, as far as the projected mining work was concerned.

Two large and powerful hoists, air compressors and other expensive machinery were brought. Two shafts were commenced in the Santa Maria to cut the Veta Negra vein at the depth of 1,200 ft., and the San Francisco to explore the Pabellon. The first shaft was never completed, although sunk to a depth of 1,000 ft., owing to lack of funds, and the Veta Negra vein and its possible bonanzas are filled with water. In the San Francisco shaft the company was more fortunate. Below the 700 level a good body of ore was struck. It occurred as one of medium grade, with occasional pockets of higher grade sulphides.

The extravagances of the management had eaten up the large working capital, and the owners were little disposed to advance more, as they had been badly bitten in other ventures, notably the Harshaw, of Arizona, the Minas Prietas, of Sonora, Mexico, and the Las Yedras, of Sinaloa, the last two of which had not begun to be profitable at that time. For this reason it became difficult to treat the ore which they had then found. It was true that the company had purchased an old Hacienda de Beneficio, but the modified patio process which had been employed before was costly, in American hands at least, and abhorrent to American minds. George Tew, who had found the property and who had succeeded, after several changes had occurred, to the management, was determined to make a profit, and with a few additions to the already heterogeneous mass of machinery, began the working of ore by roasting and lixiviation and by concentration. The concentrates were shipped to the United States and a portion, if not all the precipitates, from the lixiviation works, refined on the spot. These, later, were shipped to Denver.

Tew, in spite of his crude plant, made money until, finally, over $100,000 was on hand, when it became apparent that to work the low grade ores of the mine, as the high grade bodies had been worked out, it was necessary to erect a more economical plant. Tew's success, and the large quantity of low grade ore in the mine, aroused the interest of the owners and stockholders, the late Frederick Billings, of this city, among others, and it was determined to erect a modern plant, capable of treating the base, low grade ore at a low cost. The success of lixiviation in the old plant, and the prominence that the Russell lixiviation process was then attaining, decided the management to erect a plant to use this improved process, and elaborate plans were drawn. Mechanical roasters were to be employed instead of the old, but efficient, reverberatory furnace, rolls were to be adopted instead of a cumbersome mechanical crusher then used, and, speaking generally, every improvement then known was to be introduced, so as to make the labor employed a minimum and the extraction as perfect as possible. The mill was accordingly built with Stetefeldt dry kilns, Eckart rolls, Stetefeldt furnace and a complete lixiviation plant to treat the roasted ore.

It was not without due forethought that these devices were adopted, experiments with the Stetefeldt furnace in particular having been made on a car load of ore at the Ontario Mine, Park City, Utah. As for the Russell process, it had already been thoroughly tested, and its efficiency over the Patra process clearly proved at the old plant. All was now ready for the completion of the plant. This occurred in May, 1889.

From the very start the results were poor. The capacity of the rolls was not what was expected, the furnace did not chloridize properly, and, as a consequence, the extraction was low.

It soon became apparent that to achieve good results the ore must be crushed fine, although good results were obtained from coarse ore roasted in the reverberatory furnace. This, however, was a different matter from letting it fall through the shaft of a Stetefeldt, even when that was prolonged to a greater extent than had been done before. Then a novel experiment was employed to furnish sufficient ore to deoxidize the sulphide ore, consisting of pyrite, galena and blende; 14 tuyeres, supplied with air from the rotary blowers, were inserted at various portions of the furnace. Even this expedient was not a success, and it was not until the ore had been heap roasted, preliminary to chloridizing, that a successful run, and that a single run of small tonnage, was made. Soon after this work was discontinued, the mill being unfit for work, it was said. However, we have been informed that the extraction during the months of experimenting had not averaged over 40%, in return of bullion. The construction of the plant and the costly experiments had exhausted the treasury and the patience of those who had been advancing the money; so, through lack of funds, the mine itself was allowed to remain idle. It was then "jumped" by several Mexican residents at Sombrerete, and it was only after much trouble that the title was made clear. Now, however, we understand that the property, which is being worked under a lease by the Mexican Metallurgical Company, an offshoot of the Kansas City Smelting and Refining Company, is making money. This company built a concentration plant at the beginning of 1892, and ships the products to its own furnaces at San Luis Potosi.—*Engineering and Mining Journal.*

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